Organisms
(Level 1)

Teacher's Guide

Chester A. Lawson
Robert Knott
Robert Karplus
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Marshall Montgomery

RAND McNALLY
SCIS

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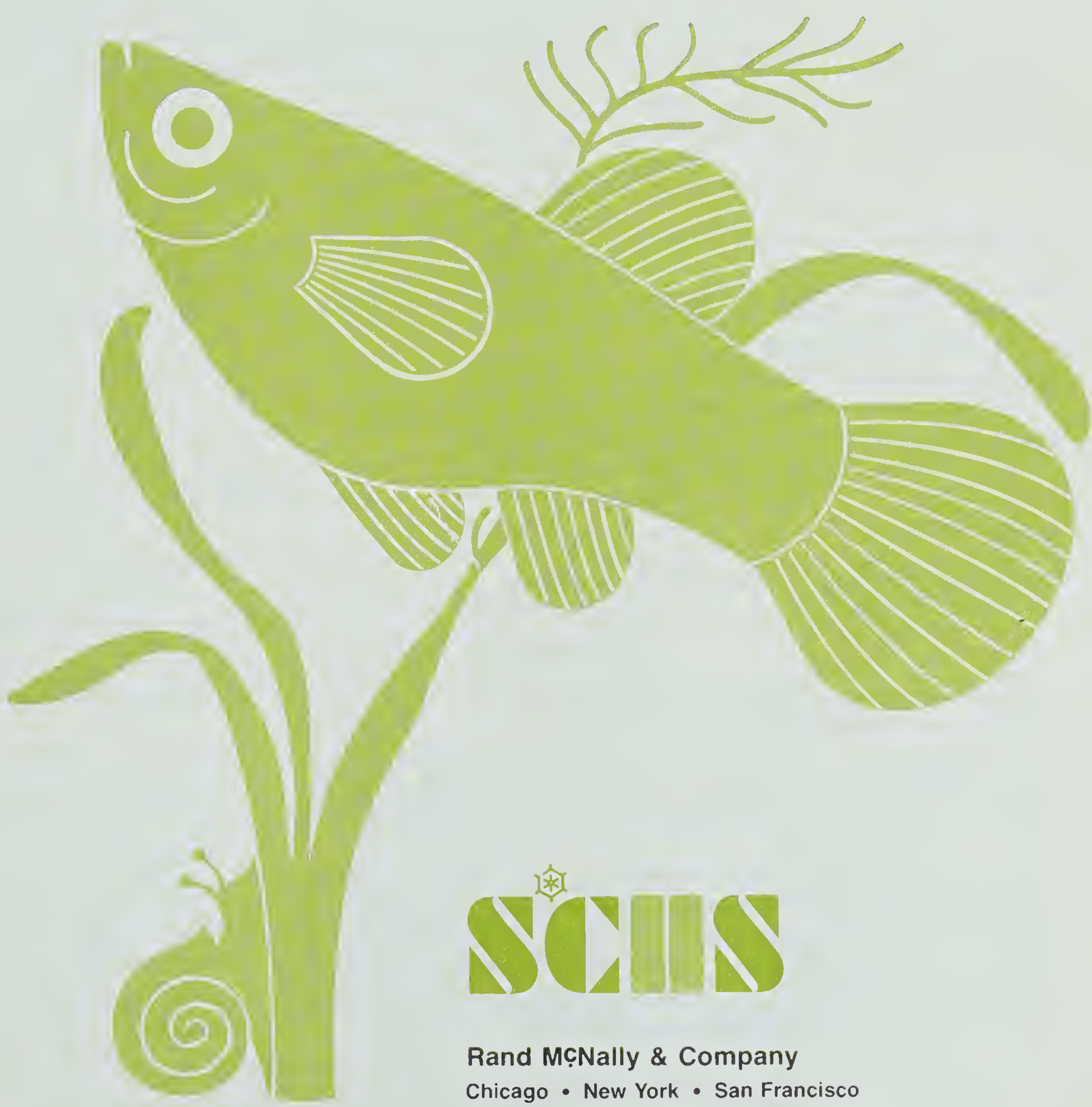

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Preface: From SCIS to SCIIS

Over the past twenty years almost a hundred curriculum projects—the majority in science—germinated on the educational landscape. Some withered, some bloomed, and some not only thrived but went on to propagate successful offspring. Among the latter has been the Science Curriculum Improvement Study (SCIS), which grew out of Robert Karplus's early studies of elementary school children and science learning in the 1960s. Funded by the National Science Foundation, and eventually housed at the Lawrence Hall of Science, University of California at Berkeley, the SCIS program became one of several curriculum projects that have markedly changed the direction of elementary science education in the 1970s. After extensive testing with thousands of students and teachers, the first commercial edition of SCIS was published by Rand McNally in 1970–72.

The educational impact and acceptance of SCIS was rapid and widespread. The insights, commitment, and enthusiasm of the SCIS developers were passed on to the teachers using the program—directly and through workshops, in-service training, and visitation programs at the Lawrence Hall. These efforts were significantly reinforced by the publisher, who sponsored additional programs for teachers, set up information and awareness centers, provided consultants, and serviced thousands of schools with its representatives. In less than three years SCIS clearly established itself as a program to emulate. No other available materials provided science educators with so much flexibility in subject matter, classroom materials, and teaching strategy, within a clearly defined conceptual framework. No other program so explicitly set scientific literacy as its overall goal for children—and then earned the documentation (mostly from independent sources) to show achievement of that goal. No other program introduced children to the life sciences by bringing live organisms into the elementary classroom for direct observation and study. And no other program that focused on *doing,* rather than reading about, science was more widely adopted and used in the schools.

For these reasons, SCIS has been a challenging program and, at the same time, one that has been a pleasure to teach and to learn from. The challenge lay in the need for the developers, the publisher, and teachers to give something more in terms of time and effort, and to effectively create, deliver, and present to students the concepts and activities embodied in SCIS. For example, one of the salient and essential features of the program is the presence of live organisms in the classroom; the culturing, scheduling, procurement, use, care, and maintenance of selected plants and animals, no matter how hardy, required a commitment over and above that needed in a "read-about" science program.

On the other hand, that SCIS has been a pleasure to teach is a judgment that comes from thousands of educators and children who have used it. An overwhelming majority have told the publisher and the authors that student interest, enthusiasm, and achievement have been markedly increased in their classes—and not only in terms of science. Language and communication skills have improved, as supported by research. Ability and willingness to observe, measure, collect data, organize information, reason, interpret, and weigh evidence have been characteristic of SCIS learners. Anticipating and then witnessing these outcomes helps to make teaching what it at least occasionally needs to be—a joyful experience.

During the 1975–76 school year Rand McNally invited approximately 500 elementary specialists and teachers using SCIS in a wide variety of locations and educational environments to review the materials and comment critically from their own experiences. They did so in person and in writing, and the resulting feedback has provided a basis for thorough revision by members of the original SCIS author team. Working together, the authors and the publisher began developing the new program you now have in hand. The task encompassed far more than merely remodeling the existing activities, books, and equipment. New activities, concepts, themes, learning components, design, packaging, sources of supply, delivery systems, and services to support teachers—these and other features of the new program were scrutinized and tested in schools or laboratories, and measured against the expressed needs of the schools.

The end result is the Rand McNally SCIIS program.

We are pleased with it. We are confident that it will provide you and your students with even greater opportunities for learning and enjoyment in science—and in ways related to other disciplines—than did its predecessor. And we want to hear from you about your experiences with it (see the Evaluation Response Form, Drawer 1, in the kit).

Finally, our thanks to the many teachers, parents, and children who voluntarily give us the benefit of their comments. We would like the reader to join them—as a user and as a friendly critic—in the ongoing task of improving science education, with SCIIS.

A note about the title and logo

We seem to be nearing a time when the supply of possible acronyms for educational programs, projects, and organizations will be exhausted. Rather than contribute to a further drain on the supply, we thought it singularly appropriate to retain much of what "SCIS" has been—in name as well as in substance. We saw the task as one of improving SCIS *from within* a conceptual and physical framework that had already proven itself in the classroom, rather than simply adding on from outside or giving the impression that we were starting from scratch again. Hence, SCIS became SCIIS, with another I inserted. And something resembling the original "snowflake" survives in the logo.

For the literal-minded, the new I may serve to represent further improvement, or more innovation, or (with its partner) a two (II). Thinking about and debating such fine points provided hours of recreation for editors, advertising staff, and project management. We would prefer that you call the program "Rand McNally SCIIS" to avoid confusion with the earlier SCIS or with other products now using a similar name.

For the Authors—
Herbert D. Thier

For Rand McNally—
William Miller

August, 1977

An Introduction to SCIIS

The Conceptual Framework

Diversity and change—in the landscape, in cloud formations, at the zoo, in a jar of sugar water forming rock candy—attract children's attention and awaken their interest. Curious about their surroundings, children naturally seek to describe and sort the diverse animals, plants, and nonliving materials they discover. In this respect they resemble scientists, who try to understand the basic conditions governing change.

THE GOAL: SCIENTIFIC LITERACY

Through investigation, scientists' understanding of nature advances from simple hypotheses to complex theories. Similarly, children's thinking advances from the concrete to the abstract as they accumulate experiences and ideas. They develop more effective techniques for observing and testing nature. In other words *they become scientifically literate.*

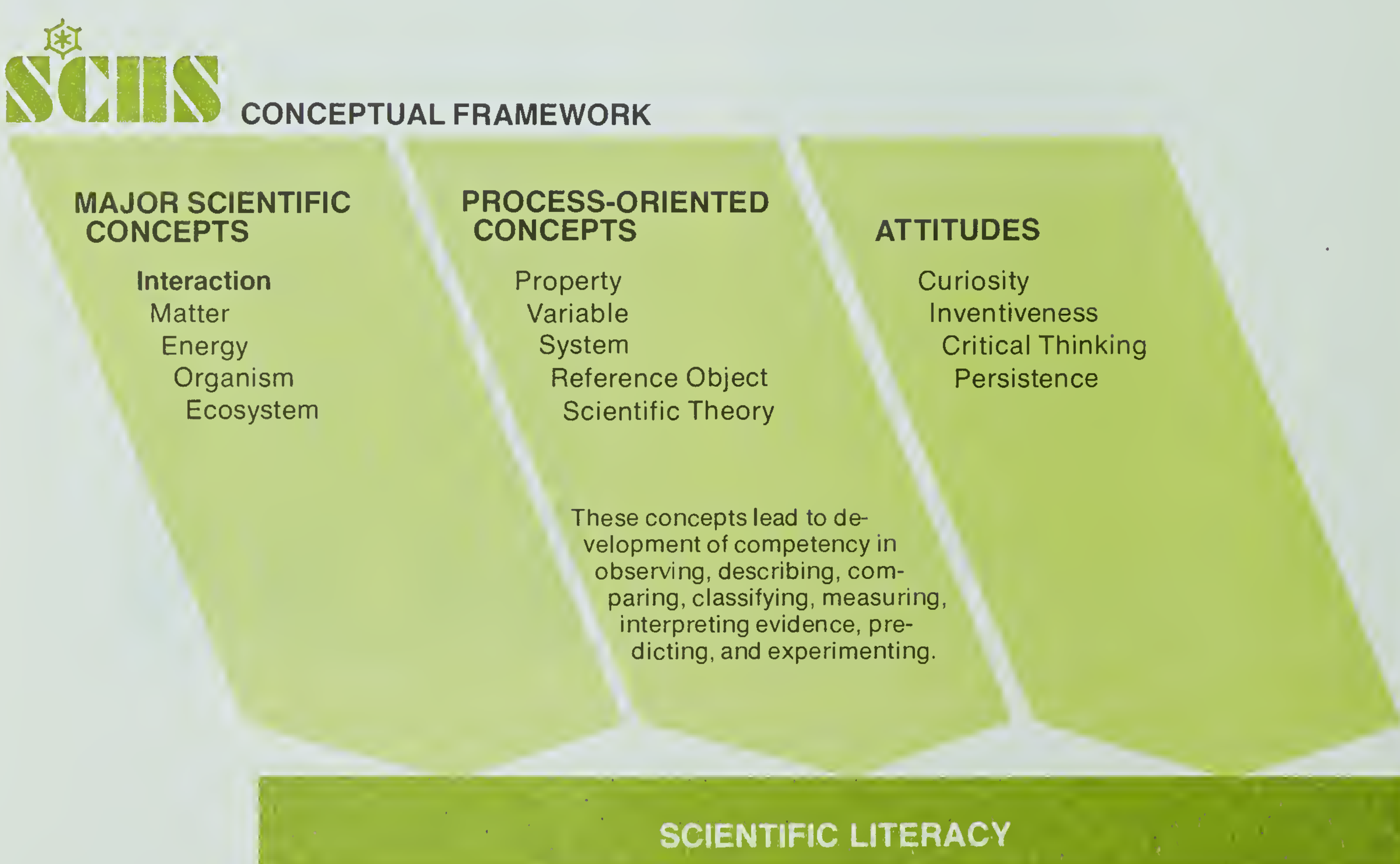
Scientific literacy derives from basic knowledge, investigative experience, and curiosity. In the SCIIS program, these three factors are integrated, balanced, and developed through the children's involvement with basic scientific concepts, process-oriented concepts, and challenging problems for investigation.

CONCEPTS, PROCESSES, AND ATTITUDES

Educators frequently distinguish among content learning, process development, and attitude formation when they describe an educational program or evaluate its outcomes. The SCIIS program combines these three factors into an integrated whole, matching the way children learn. Children are introduced to scientific content through firsthand experiences—with magnets, gears, fish, crickets, and a wide range of other living and nonliving materials.

In the course of their investigations, children engage in observation, measurement, interpretation, prediction, and other processes essential for the development of scientific literacy.

Finally, the SCIIS program helps children form positive attitudes toward science as they explore



phenomena. Using their own ideas and preferences, they learn to cope confidently with new and unexpected findings by sifting evidence and forming conclusions—thus removing the "magic" from science.

Major Scientific Concepts *Interaction.* The concept of *interaction* is central to modern science—and therefore also to the SCIIS program. This concept embodies the scientific view that changes in nature take place because objects interact in reproducible ways when conditions are controlled. In the scientific view, changes do not occur because they are preordained or because a "spirit" or other power within objects influences them capriciously.

When objects or organisms do something to one another that brings about a change, we say that an interaction has occurred. When you clap your hands, they interact with one another and the air. The observed changes, the sensation in your palms, and the sudden sound are evidence of interaction.

Children can easily observe and use such evidence. They can watch a guppy eat a daphnia, hear bubbles when seltzer tablets dissolve, spin a compass pointer with a magnet, and detect the odor of decomposing organic materials. As they advance from dependence on concrete experiences to the ability to think abstractly, children can identify the conditions under which interactions occur and predict their outcomes.

In SCIIS, four major scientific concepts elaborate the interaction theme—*matter, energy, organism,* and *ecosystem*. Children's experiences and investigations in the six units that make up the physical/earth science sequence are based on matter and energy.

Organism and ecosystem provide the framework for the six units in the life/earth science sequence. Additional concepts are described in the appropriate Teacher's Guides.

Matter. Matter, or material, is introduced in the SCIIS program through the solids, liquids, and gases in the environment. These interact with human sense organs and with each other. Material objects can be described and recognized by their color, shape, weight, texture, and other properties. As children investigate changes in objects in the SCIIS physical/earth science sequence, they become aware of the diversity of interacting objects and their properties.

Energy. Energy is the inherent ability of a system to bring about changes in itself or in the state of its surroundings. Some familiar energy sources are the natural gas used to heat a kettle of water, the horse used to pull a plow, the unwinding spring that operates a clock, and the discharging battery in a pocket radio. The complement of an energy source is an energy receiver, such as the football kicked by a player or the ice cube placed in warm water. The interaction between energy source and receiver results in energy transfer.

Organism. An organism is an entire living individual—plant or animal. It is composed of matter, and it uses the energy from its food to develop, grow, and be active. The organism concept represents a fusion of the matter and energy concepts, but it is much broader than the sum of its parts. An essential factor is the organization of matter into cells and other structures that assure continuity of life from generation to generation.

Ecosystem. Awareness of the interactions between organisms and the environment leads to the ecosystem concept. As children observe living plants and animals in the classroom or out-of-doors, they notice the amazing diversity of organisms and their life cycles. They observe how plants and animals interact with one another and with the soil, atmosphere, and sunlight in the complex network of relationships that constitute an ecosystem.

Think of a forest as an example. A forest is more than an assemblage of trees. Living in the shade of trees are shrubs, vines, herbs, ferns, mosses, and toadstools. Dependent upon these plants and living among them are insects, birds, mammals, reptiles, and amphibians. The animals depend on plants for food, shelter, and other needs. The plants use sunlight, carbon dioxide, water, and minerals to make food that sustains themselves and other organisms in the forest.

Process-Oriented Concepts. By defining and emphasizing specific concepts, SCIIS permits teachers and pupils to concentrate on the objectives of the program. Five process-oriented concepts—*property* (or characteristic), *variable, system, reference object,* and *scientific theory*—underlie and are essential for development of competency in the processes of observing, describing, comparing, classifying, measuring, interpreting evidence, predicting, and experimenting.

Property. We have already referred to the properties by which an object may be described or recognized. A property is any quality that enables you to describe, compare, or classify objects. Color, size, shape, texture, and scent are properties of a blossoming plant; color, density, and hardness are properties of a mineral specimen; and size, color, and style are properties of a suit of clothes.

Properties also enable you to describe concepts. For example, duration is a property of a time interval; accuracy is a property of a carefully-made measurement; and the term climate (hot, cold, temperate) summarizes the properties of weather in a specific region.

Variable. Properties and conditions that differ from one experiment to another are important in scientific

work, and they have been given a special name—variables. Examples are the temperature of water being warmed by the sun, the amount of fertilizer added to a potted ivy plant, the length of time a flashlight battery has been used, and the number of crickets feeding on a particular patch of grass.

System. System is a word that has entered everyone's vocabulary. We deal with the nervous system, communications systems, electronic systems, and systems analysis. In all of these a system is a whole made up of related parts. Earth and its moon form a system of two closely interacting bodies in space. A seed, moist soil in which it is planted, and air form a system. The system concept reflects the fact that objects and organisms do not function in isolation but exist in a context of interaction with other objects or organisms.

When one system is part of another system, it is called a *subsystem.* The earth, including its atmosphere, plants, and animals, is a subsystem of the earth-moon system. The seed, with its embryo, seed coat, and stored food, is a subsystem of the seed-soil-air system.

The terms object, subsystem, and system allow us to use three levels for grouping the elements that attract our attention in an event. We shall use the word "object" for individual pieces of matter, "subsystem" for intermediate groups of objects, and "system" for the largest collection under consideration.

We have concentrated on "closed" systems in the SCIIS physical/earth science sequence. A closed system is defined by the matter of which it is composed. Whenever matter is added to, removed from, or replaced by, other matter, the original system becomes a new system. When nothing is added or removed, a system retains its identity even though it may change in form or appearance.

Sometimes (especially in the life sciences) scientists find it useful to work with "open" systems, which are defined by the matter occupying a certain region of space. The air space within a terrarium is an example. In an open system there may be changes of matter without changes in identity—as when water vapor, carbon dioxide, and oxygen enter and leave the air even though the terrarium is covered. The ecosystems children investigate in Level 6 are examples of open systems. Children who continue to study science may learn to distinguish between open and closed systems when that distinction becomes important.

Reference object. The fourth process-oriented concept, reference object, helps children overcome the limitations of describing position and motion only from their own point of view. Space exploration has shown that we can no longer think exclusively in terms of up-down and north-south as defined on earth. For young children—who at first relate objects only to themselves—the use of external reference objects is a challenge.

In SCIIS, the basic concept is simple: Position and motion of objects can be described only with reference to other objects, including (possibly) the body of the observer. When you say, "Meet me at the north end of the picnic area," you describe the location of the meeting place relative to the picnic area. In the example, the picnic area serves as reference object and the compass direction serves as reference direction. When you say, "The main entrance to the museum is to your left," you are using the listener's body as reference object.

The child who can take into account several reference objects and reference directions overcomes a spatially self-centered viewpoint. The concept of Earth as a sphere in space can be understood only in relation to a reference object not located on the earth itself; therefore an understanding of reference objects is fundamental to further work in earth and space sciences.

Scientific theory. An example of a scientific theory is the ray theory of light, which holds that light consists of rays propagating from a lamp or other light source to your eye or an illuminated object.

An everyday example of theory-building can be derived from a look at a common pay phone. How does the coin turn on the phone connection? One might imagine that the coin falls on and depresses a small platform, thereby closing a switch. What is your theory of how the coin turns on the telephone? Keep in mind that many phones work with a dime but not with a nickel, or with two dimes but not with three nickels, even though a nickel is heavier than a dime.

Scientific theories provide explanations for natural phenomena such as light, photosynthesis, weather, heredity, chemical combination, or the solar system. A theory usually postulates certain unseen relationships or objects, such as light rays emanating from a lamp, the platform in a telephone, or atoms in a material substance. Theories also lead to predictions and new discoveries about the events being investigated. If the predictions are not borne out, a theory may be discarded. By using scientific theories, children can relate present observations to previous and subsequent experiences with similar events.

Structure and Content

The SCIIS program consists of thirteen learning units in science for children at preschool, kindergarten, and elementary school levels. The introductory unit, *Beginnings,* leads into two six-unit sequences—the physical/earth science sequence and the life/earth science sequence.

The two sequences are complementary in that either of the two units for any one level may be used first. For example, at Level 1 you may use *Material Objects* in the fall and *Organisms* in the spring, or vice versa. This flexibility permits switching of units between two classes at midyear. (Supplementary and alternate packages of materials are available for schools wishing to switch units, to share unit kits among two or more classes, or to supply exceptionally small or large classes.)

The physical/earth science sequence guides children through carefully selected investigations of the physical world. In the same way, the life/earth science sequence focuses attention on the biological world. Both sequences include treatment of some topics relating to the earth sciences—shadow astronomy, map coordinates, water and mineral cycles, and climatic factors are examples.

SYNOPSES OF THE UNITS

Concepts and processes developed and emphasized throughout the SCIIS program have been described in the preceding "Conceptual Framework." The following summaries list the concepts and processes most important within each unit.

Level K *Beginnings*

Concepts and processes emphasized in this unit: color, shape, texture, odor, sound, size, quantity, position, organism.

The *Beginnings* unit for kindergarten and early childhood education offers a wide variety of activities and experiences in both life and physical sciences. Most of the activities are designed for use in small-group learning situations. Children learn to observe, discriminate, and describe, using objects and organisms in the classroom and outdoors. These early experiences help them develop language and participation skills and contribute to their growing understanding of science. The unit leads into the physical/earth science and life/earth science sequences.

SCIIS STRUCTURE AND SEQUENCE OF UNITS

K	BEGINNINGS	
	Physical/Earth Science Sequence	Life/Earth Science Sequence
1	MATERIAL OBJECTS	ORGANISMS
2	INTERACTION AND SYSTEMS	LIFE CYCLES
3	SUBSYSTEMS AND VARIABLES	POPULATIONS
4	RELATIVE POSITION AND MOTION	ENVIRONMENTS
5	ENERGY SOURCES	COMMUNITIES
6	SCIENTIFIC THEORIES	ECOSYSTEMS

Physical/Earth Science Sequence

Level 1 *Material Objects*
Concepts and processes emphasized in this unit: object, property, material, serial ordering, evidence.

The children handle, observe, and describe objects. They learn that objects are composed of materials and have properties by which the objects can be discriminated; that some objects are solids, while others are liquids or gases; that objects can change; and that there are ways to recognize evidence of change. Property comparison leads to the concept of serial ordering. As the children investigate the properties of various materials, they realize that the same substance can exist in more than one form, and they gain an awareness of the principle of conservation of matter.

Level 2 *Interaction and Systems*
Concepts and processes emphasized in this unit: interaction, system, evidence of interaction, interaction at a distance.

The concept of interaction is introduced, as well as the concept that related objects or parts comprise a system. Students examine a variety of interactions, some of which are directly observable, others less apparent. The evidence that an interaction has taken place comes from the observed change in the system. The children investigate gear/pulley systems, chemical systems, magnetic systems, and electric circuits to observe and interpret evidence of interaction.

Level 3 *Subsystems and Variables*
Concepts and processes emphasized in this unit: subsystem, solution, evaporation, histogram, variable.

The subsystem concept is introduced to give the children a grouping of objects intermediate between a single object and an entire system. The children's work with solid and liquid materials extends their understanding of the subsystem concept. They learn that filtering will separate an undissolved solid from a liquid, but that solids dissolved in solutions must be identified by the residue that remains after the liquid evaporates. Histograms are used to record and interpret data collected by the students. The variable concept helps them to identify and investigate factors influencing their experiments.

Level 4 *Relative Position and Motion*
Concepts and processes emphasized in this unit: reference object, relative position, relative motion, polar coordinates, rectangular coordinates.

The ideas and techniques developed in this unit are related to concepts of earth and space science. Students find that descriptions of position and motion are meaningful only if reference to objects and coordinate systems—both polar and rectangular—are included in the descriptions. An artificial observer, Mr. O, serves the children as an introductory reference object. They see that reference to different objects and coordinate systems leads to different descriptions of position and motion. They also learn to use a variety of reference frames to describe the position and motion of objects in their everyday environment.

Level 5 *Energy Sources*
Concepts and processes emphasized in this unit: energy source, energy receiver, energy transfer, energy chain.

The concepts of energy source, energy transfer, and energy receiver constitute the core of the unit and are illustrated with experiments exploring mechanical and thermal systems. The importance of solar energy to meet some of our needs is emphasized in this unit. The children's descriptions of the amounts of energy transferred from a source to a receiver help to prepare them for understanding and applying the principle of conservation of energy.

Level 6 *Scientific Theories*
Concepts and processes emphasized in this unit: scientific theory, color, magnetic field, electricity, light ray.

The extended investigations and formulation of scientific theories in this unit conclude the physical/earth science sequence. In *Scientific Theories,* children create their own theories to explain their observations of colored light, magnetic interactions, electric circuits, and simple ray optics. Investigations provide opportunities for students to think of theories to explain the operation of systems of interacting objects and to devise tests to distinguish among alternate proposals. In doing so, they gain a deeper understanding of how scientists work.

Life/Earth Science Sequence

Level 1 *Organisms*
Concepts and processes emphasized in this unit: organism, birth, death, habitat, food chain, decay.

The stage is set for the unit as children plant seeds, watch the growth of the seedlings, and experiment to see how external conditions affect growth. Their observations are extended to a model ecosystem—an aquarium. They observe changes that occur in the aquarium, including the growth of plants and animals, animals feeding on plants, animals eating other animals, birth, death, and decay. Experiences with classroom plants and aquariums give children a general introduction to the overall theme of the life/earth science units: interaction of organisms with their environments.

Level 2 *Life Cycles*
Concepts and processes emphasized in this unit: growth, development, life cycle, genetic identity, plant and animal, metamorphosis.

Attention is shifted from the ecosystem as a whole to some of its important parts—individual plants and animals. Through experiences with living, dead, and nonliving objects, the children have an opportunity to learn these classifications of objects around them. Living and dead organisms are further subdivided into plants and animals. By observing live, growing, developing, reproducing plants and animals, the children become aware of the fact that living objects have life cycles.

Level 3 *Populations*
Concepts and processes emphasized in this unit: population, plant-eater, food web, biotic potential, animal-eater, plant-animal-eater, predator-prey.

The children learn that the individual plants and animals they observed in previous units live as groups in nature. They build, maintain, and observe terrariums and aquariums, and they investigate the interactions of populations—food webs, for example—in each system. The concept of biotic potential can be inferred after the pupils are asked to imagine, with the help of prepared charts, what could happen in a population if reproduction continued without any deaths.

Level 4 *Environments*
Concepts and processes emphasized in this unit: environment, environmental factors, biotic, abiotic, range, optimum.

The environment of an organism consists of biotic factors, which include all the other plants and animals living in the same area; it also includes abiotic factors, such as light, temperature, air, water, and soil. The children experiment with both plants and animals to discover the effects of changing various factors, to establish a range of conditions for testing each factor, and to find the optimum part of a range for each organism. On the basis of data collected from these experiments, students build terrariums with suitable environments for the organisms. They discuss and plan a human environment that includes other organisms on which humans depend.

Level 5 *Communities*
Concepts and processes emphasized in this unit: pyramid of numbers, raw materials, reproduction, community, producers, consumers, decomposers, photosynthesis, food transfer, competitors.

In *Communities,* emphasis is placed upon interactions among different populations of organisms, the most important of which concerns food. Students examine the interdependent relationships among plants (as producers), animals (as consumers), and microorganisms (as decomposers). The children investigate the capacity of green plants to produce food. They build terrariums containing plants, crickets, and salamanders, and observe the food-chain relationships. And they observe the results of decomposition after burying dead crickets in moist sand.

Level 6 *Ecosystems*
Concepts and processes emphasized in this unit: ecosystem, water cycle, oxygen-carbon dioxide cycle, pollution, food-mineral cycle.

The cycle concept is introduced by means of experiments with evaporation and condensation of water that lead to an understanding of the water cycle. Students learn that the ecosystem is maintained by the intake of energy from the sun and by the continuous recycling of materials between organisms and the environment that surrounds them. Ecosystems are seen to include all the concepts in the life/earth science sequence as children see the pattern of ecosystems in North America and identify their own ecosystem. Changes in the balance in natural ecosystems, including those caused by pollution, are studied.

Helping Children Learn with SCIIS

SCIIS is a science program based on direct experience. It is intended to affect the ways children think and reason. In addition it is expected to influence how they will reason and make decisions about problems when they become teenagers and adults. Such thinking and decision-making may well determine the individual's responses to a wide variety of personal and societal issues: Should I smoke or not? Should I vote for or against the use of coal as an energy source in my community? In both cases the intelligent person must be able to understand the variables, critically assess advertising campaigns and the statements of special interest groups, and separate emotional appeals from real evidence.

SCIIS fosters this kind of thinking and decision-making, which is quite different from the kind of skill-oriented learning that takes up a large part of the child's elementary school experience.

The need for skill learning. Children need to learn the skill aspects of language, writing, and arithmetic. Your role in teaching these skills is that of an instructor (one who imparts information) who knows precisely what is to be learned and "gets it across" effectively. The importance of such instruction cannot be questioned, because the skills are basic to participation in society.

Development of reasoning. The individual, however, deserves and needs a great deal more than skill learning to participate meaningfully in a democratic society. The ability to use one's own experiences as a foundation for understanding, interpretation, and decision-making in life is essential. It is this ability to observe, collect evidence, analyze, and use the information obtained from one's experiences that is emphasized in the SCIIS program.

For these reasons your role when teaching such experience-based science is that of a helper and fellow-investigator, rather than only that of an authority or imparter of knowledge. The sections that follow describe the components and organization of SCIIS, and how you can use the program to help children learn both science and the approach to decision-making inherent in science.

PROGRAM COMPONENTS

Teacher's Guide. Central to each unit of the SCIIS program is the Teacher's Guide. It shows how the unit is broken into parts and chapters. Specific learning objectives are listed at the beginning of each Part. The rationale underlying the Part is explained under the heading "Background Information." Next is an "Overview" of the chapters that make up the Part. Any suggestions for organizing time and equipment are provided in notes titled "Planning Ahead" and "Getting Ready."

Each chapter begins with a color panel containing a synopsis, the time suggested for working through the chapter, and a list of materials needed for the activities. Major headings within a chapter are "Advance Preparation," "Teaching Suggestions," "Optional Activities," and "Extending Your Experience (EYE) cards." If background information specific to the chapter is needed, it precedes "Advance Preparation."

At the end of each Part, notices tell you which EYE cards (in the kit) may now be made available to the children and refer you to the appropriate evaluation activity at the back of the Guide.

Following the last chapter of the Guide you will find an "Evaluation" section, a glossary of important terms, and a page explaining design and use of the equipment and materials kit. The life/earth science units also contain an appendix on care of organisms (following the glossary) and an overall schedule of activities.

Scheduling. One activity may extend beyond a single science session, or several activities may be included in one session. The "Suggested time" for working through a chapter is *only* a suggestion; adapt your schedule to allow for special student interest or for greater use of a chapter or activity that is particularly appropriate in your locale.

Teaching suggestions. Under this heading you will find all the activities intended for use by the whole class. Most activities are carried out by individuals or teams working with the necessary materials to collect data or other evidence. While this happens, you are free to move around the classroom to help those who have problems.

Once the data are collected, conduct a discussion of the results, and encourage children to draw conclusions about the data. The work with the equipment and materials and the subsequent discussions are fundamental to the reasoning and decision-making processes SCIIS is designed to foster.

A willingness to improvise and depart from the teaching suggestions will better enable you to meet your pupils' needs. Students may ask questions not anticipated in the Guide or that do not lead in the direction you planned. When this happens, permit the pleasure of a "side trip" by encouraging interested individuals or small groups to investigate independently and report back to the class.

Optional activities. In many chapters individual and small-group needs and interests are met by the "Optional Activities" section. These expand upon topics brought up in the chapter or help in reviewing concepts studied earlier. You may use optional activities to:

- extend the main activities if a child raises a related question
- emphasize one topic for the entire class
- expand the unit extensively if your class is more mature than usual for this level

Optional activities make use of materials provided in the program, common household supplies, or other readily available items. We hope you will include at least a few of these activities in your program, but we do not expect you to use all of them.

Evaluation and feedback. Feedback is information that comes to a person in response to something the person did. As a teacher, you are collecting feedback from your pupils most of the time. An answer to a question yields feedback. So does a child who looks out the window during your demonstration. Informal feedback is an important way to evaluate the progress of your class. In this Guide, we will try to alert you to feedback situations in which children's responses are likely to influence your teaching plans.

In addition to the feedback suggestions included in each chapter, we have prepared an evaluation section that uses a more formal approach to evaluating your students' learning. In general, there is one evaluation activity for each Part of the unit.

Teacher's glossary. Scientific terms and concepts used in the unit are defined in the glossary. The definitions are appropriate for reference during discussions or review and are not intended to be technically exhaustive. We do *not* recommend that you use the glossary to have children memorize formal definitions of terms and concepts.

Equipment and materials kit. Each SCIIS kit includes all necessary materials for the unit except live organisms, common items such as pencils and paper, and perishable items such as batteries.

Each chapter in the Teacher's Guide begins with a list of materials needed and their location in the kit. Starred (*) items in the list are to be provided by the teacher. "Design and Use of the Kit" (page 84) and labels on each kit drawer also indicate placement of items.

Live organisms. The life/earth science units require that you order shipments of live organisms (already paid for), prepare suitable habitats, and allow time for growth and development of the organisms. The life/earth science kits contain the forms for ordering SCIIS organisms. At the back of the Guide, the "SCIIS Plants and Animals" appendix and the "Schedule of Activities" will help you plan and carry out all work with live organisms.

Student manual. The student manual has two major functions: It helps guide the children through their experiences with the equipment and materials, and it provides a place for the individual to record observations, findings, or measurements. During many activities the children record information about experiments in their manuals. This may provide the basis for later discussions.

Encourage children to make entries independently, even though their reports may disagree with those of classmates or with what you consider to be "correct." Some children may change their responses; let them cross out the first entry and add the new one. In this way, their original record is preserved and may be compared with later observations. Records in the manual should be informative, but they need not be perfect.

In addition to organizing the children's work and record-keeping, the manual contains some problems to be solved either individually or in class discussion. But most of the manual is directly related to the children's experiences with the equipment and materials. This relationship makes the SCIIS student manual different from the typical elementary "workbook."

Collect the manuals periodically to review the children's record-keeping and problem-solving abilities. We suggest you refrain from writing in the manuals, either to commend or to correct mistakes. If you find repeated errors in reasoning or data interpretation, arrange for a conference with the child.

Extending Your Experience cards. These cards (two duplicate sets with a display box) are provided primarily to encourage development of individual interests. We have controlled vocabulary on the cards, so that most children should be able to read them unassisted. The illustrations are intended to help the children work independently. Make each card available — by adding it to those in the display box — at the time its use is recommended in the Guide.

The cards may be used in a variety of ways, ranging from totally independent work to a more controlled situation in which you or an aide suggest and supervise a pupil's use of a card.

Some cards may be used for review or remedial purposes. Some may be assigned to provide additional experiences for children new to the SCIIS program. The cards to be used with review chapters at the beginning of the Guide will prove useful for these purposes.

Encourage children to report orally, in writing, or through picture displays after they complete work with a card. They can report to you, to their team, or

to the class as a whole. In this way, children can benefit from the opportunities for language development inherent in the use of the cards.

As children express interest in topics not covered by the cards provided, you might help them develop new cards that relate to their specific interests.

THE LEARNER IN SCIIS

The SCIIS program is intended for children between the ages of 5 and 12–13 years. Therefore, the teaching approach needs to be matched to the learning styles, interests, and capabilities of children of these ages. Research on the learning of young children has led us to recognize a three-stage development in the way children learn. These stages are explained more fully in the following sections.

Exploration. Children learn about something through their own spontaneous handling and experimenting with objects to see what happens. Thus in SCIIS children first explore materials with minimal guidance in the form of instruction or specific questions. The materials have been carefully chosen to provide a background for certain questions the children have not asked before.

You can help exploratory activity by asking questions and making comments that encourage further involvement. An individual's creative use of materials can be pointed out as a means of providing others with new ideas. During exploration activities you have the opportunity to observe the children and draw conclusions about their existing ideas and understandings. This evaluation can be the basis for further planning and instruction.

Invention. Spontaneous learning is limited by preconceptions. After exploration, a child needs new concepts to interpret observations. Since few children can phrase new concepts by themselves, you will have to provide definitions and terms as new concepts arise. This constitutes the "invention."

During an invention lesson, be clear and explicit when you give a definition, repeating it several times if necessary. To give the children opportunities to use a concept, encourage them to look for examples that illustrate the new idea. When they report such examples — immediately or during later discovery activities — you gain feedback about their understanding of the concept.

Keep in mind that the "invention" or introduction of a new concept is just the start of an experiential process for a child. Knowledge, understanding, and eventual ability to use the concept in daily life will come from experiences the child has during and after the discovery activities.

Discovery. We use "discovery" to describe those activities in which a child finds a new application of a concept through experience. You may plan a variety of situations leading to discovery, or you may depend on a child's own experiences to furnish these applications. Discovery activities strengthen the original concept and enlarge its meaning. Mastery and retention of concepts are aided by practice and repeated application in the variety of situations provided in the activities.

During discovery sessions, your role is to assist the children so they can effectively work with materials and see how concepts apply. In this stage they are actively involved, and you can spend your time with individuals or small groups to observe their work and to ask questions that spur further investigation. Where necessary, reintroduce the concept previously explained or review earlier ones.

The learning cycle. Exploration/invention/discovery are stages in a learning *cycle* because each stage can always lead to another. Exploratory sessions frequently include discovery activities for prior concepts while creating a need for your introduction of the new concept. Invention sessions frequently lead to questions best answered by giving children opportunities to work on their own, and thus to discover applications of the new concept. Discovery activities can provide opportunities to reintroduce concepts "invented" earlier and they can permit children to explore the next concept. Diagrammatically we can represent the learning cycle this way—

The Learning Cycle

At the beginning of the "Teaching Suggestions" for each chapter we have indicated the stage(s) of the learning cycle emphasized in the activities that follow.

Implementing learning stages. Exploration, invention, and discovery can be implemented with varying degrees of direction. A more structured approach is illustrated when an entire session is used for introduction of a concept in a presentation to the whole

class. This should be preceded by exploratory activities and followed by discovery activities of a more personalized nature.

Using a less formal technique, you may introduce a new concept to individual children during their exploratory or discovery activities. To do so, join one child or a small group and use the child's own equipment to illustrate the concept. This method may be used effectively during the review chapters at the beginning of each unit after Level 1. Regardless of the approach you choose, you may have to explain and illustrate a new concept repeatedly to individual children during discovery activities.

TEACHING APPROACHES AND STRATEGIES

Organizing the classroom. Teachers who have contributed to the development of the SCIIS program have found that many responsibilities for preparation and cleanup can be shared by pupils. The following suggestions will help your class enjoy successful laboratory sessions:

1. In many SCIIS activities, children work in small teams — usually pairs. Plan teams carefully, to insure maximum cooperation.
2. For ease in managing supplies and cleanup, assign two or three teams to a work area — a table, or several desks of equal height pushed together. Such a group can share one water container, one waste pail, soil, and other shareable items. They also can exchange ideas about the activity. One member of each group may serve as a laboratory aide.
3. Ask your aides to assemble supplies for each team or group and to help you in passing out equipment. Or you can have them assist you in placing sets of equipment at distribution stations around the room. You may want to post signs at stations to identify equipment and indicate how much is to be used by each team.
4. Invite parents or other community members to assist you as aides in the class. Invite individuals with scientific backgrounds or interests to present special activities relating to activities under way, or to supervise a team working on a special project.

Discussions. Conversation among children or between teacher and children is an important part of the learning process. While participating in experiments, children spontaneously exchange observations and ideas with one another. During an invention session, you illustrate and explain a new concept. When gathering feedback, you may address a question to a particular child.

On other occasions, we suggest discussions in which the children report on their experimental results, compare observations, and sometimes challenge one another's findings. Many children should participate in these discussions, and you, the teacher, should avoid controlling the topic or the pace. Encourage the children to comment to one another, without calling on specific individuals to recite in turn. Grouping them to face one another around an open area promotes exchanges.

If you call attention to disagreement between two findings, you invite evaluative comments and suggestions — which may lead to further meaningful discovery activities. Announcing that one child is right and another one wrong rarely leads to further discovery experiences. Instead, such action encourages children to ask you, as the authority figure, for the answers; it reduces their commitment to independent investigation — which is fundamental to an understanding of science.

Asking questions. The questions you ask and the way in which you ask them will affect the children's work and attitudes. Note the difference between "What did we study yesterday?" and "What did you find out yesterday?" Though both questions call for review of a previous activity, the former only seeks an answer already in the teacher's mind. The latter inquires into a child's own experience.

A question that aims for a predetermined answer is often called *convergent* because of its specific goal. Most questions in multiple-choice tests are of this nature (as are many questions asked by some teachers). A question that allows a variety of answers is often called *divergent* because it may lead in many directions. Provocative discussion questions are usually of this nature.

Suit your questions to your purpose. If you wish to gather feedback about understanding or recall of a certain fact, ask a convergent question. Often this is best done individually, perhaps while small-group work is in progress. When you are looking for a specific answer, make this clear to the child.

If you wish to spark discussion ask a divergent question, and then sit back while several children propose answers. If the children continue their discussion without your leadership, so much the better.

Language development. During extensive use in urban, rural, and suburban schools, the earlier SCIS program proved to be particularly helpful in improving children's oral language skills. Experience with the program was especially effective in the case of disadvantaged children, whose desire to participate in class discussions increased greatly.

In SCIIS we have increased the suggestions and ac-

tivities especially designed to encourage oral and written language development. The addition of Extending Your Experience cards, for example, encourages language development, since the child is asked to describe orally, write about, or prepare a display about the results of the activity.

Mathematics development. The SCIIS program can also do much to encourage children's development of mathematical concepts and processes. Children are urged at all levels to consider the quantitative aspects of their observations and activities. For example, in the *Material Objects* unit (Level 1) the child's concept of number is reinforced by having the child select a specific number of objects as indicated by a numeral card you display. Later, in *Subsystems* and *Variables* (Level 3) and *Environments* (Level 4) the use of quantitative measurements to produce histograms and graphs is emphasized. Such use of quantitative data provides opportunities for reviewing mathematical concepts, processes, and skills. For many children the introduction to histograms and graphing will be their first experience with these powerful mathematical tools.

Children new to the program. The great appeal of SCIIS derives from its reliance on direct experience, and most children will learn quickly how to participate effectively. However, a few may have difficulty because they lack background or are not accustomed to working independently. You can take several steps to make the transition easier for them.

First, all units after Level 1 begin with a review. By supplementing the review with appropriate activities and EYE cards from previous units, you can help children become familiar with concepts introduced earlier in the program. Use these activities individually or with groups.

Second, you can help a child gain confidence in independent work by showing him or her that there are often a number of alternate acceptable procedures and results in an activity. Encourage the children to find various ways to use pieces of equipment, commend their ideas, and let them share their findings with others.

Organisms: An Overview

Experiences with classroom plants and aquariums give your students a general introduction to the overall theme of the SCIIS life science units: interaction of organisms with their environments. Ecological concepts such as *habitat* and *food chain* will be expanded and built upon in units at higher levels until the children are capable of considering the ecosystem concept in some detail in the sixth level.

The stage is set for the unit in Part One as children plant seeds, watch the growth of seedlings, and experiment to see how external conditions affect growth. Next, their observations are extended to other organisms in a different kind of environment—an aquarium. Then they look at the larger, outdoor environment on a field trip. From these explorations they are led to "invention" of the concept *habitat*.

The aquariums are studied as they change through the semester. In Part Two, boys and girls watch *birth*, growth, and *death* of aquarium plants and animals. Aquarium habitats are emphasized in Part Three. A major, visible change occurs in aquariums kept in the light: the water turns green as the algae (tiny green plants) in it multiply. Children experiment with the water in Part Four and eventually learn that algae cause the color change. The concept *food chain* is invented in Part Five after children observe *Daphnia* (water fleas) eating algae and being eaten in turn by guppies. This general principle—the transfer of materials through ecosystems—is then extended to the cycling of wastes. Part Six begins as children observe the accumulation of fecal and dead materials on the aquarium sand, learn that the "black stuff" is called detritus, and infer from experiments that detritus acts as a fertilizer, enhancing plant growth. The pupils then redirect their attention to the specific questions that began the unit—questions about factors affecting plant growth.

Concepts. Each encounter with living organisms should increase awareness of the differences between living and nonliving things (a subject that will begin the next unit, *Life Cycles*). While building that awareness, children will develop some understanding of these basic biological concepts:

organism	**habitat**
birth	**food chain**
death	**decay**

Lesser concepts that add to the children's understanding include: male, female, and detritus.

Part One

Seeds and Plants

OBJECTIVES

To describe seeds and to grow plants from seeds.

To state some requirements for seed germination and plant growth.

BACKGROUND INFORMATION

A mature seed consists of a small plant embryo and a food supply, both enclosed in a protective seed coat. When the seed is soaked with water, the seed coat softens and breaks open. The embryo uses up the food supply and becomes a seedling as tiny roots, stem, and leaves develop. If the seed is in soil, the seedling's roots grow into the ground, and its stem and leaves extend upward into the air. If favorable amounts of water, light, and heat are present, the seedling will begin manufacturing its own food supply to support continued growth. When mature, the plant will produce flowers and seeds of its own.

Plants need minerals, water, air, light, and a suitable temperature to grow and complete their life cycles. Minerals and water in the soil are taken up by the roots, while pores in the leaves permit air to pass into the plant. Plants growing outdoors receive light and heat from the sun, but plants grown indoors may need a supplemental source of light and heat.

Growth rate and size vary from one kind of plant to another. They also vary among individual plants of the same kind, depending on the conditions in which they grow. Some plants flower and produce seeds in a few weeks, and others take months to complete the same process.

OVERVIEW

In Chapter 1, "Observing and Planting Seeds," children compare characteristics of four kinds of seeds, then plant them. They guess how often their plants need watering and experiment to see who is right.

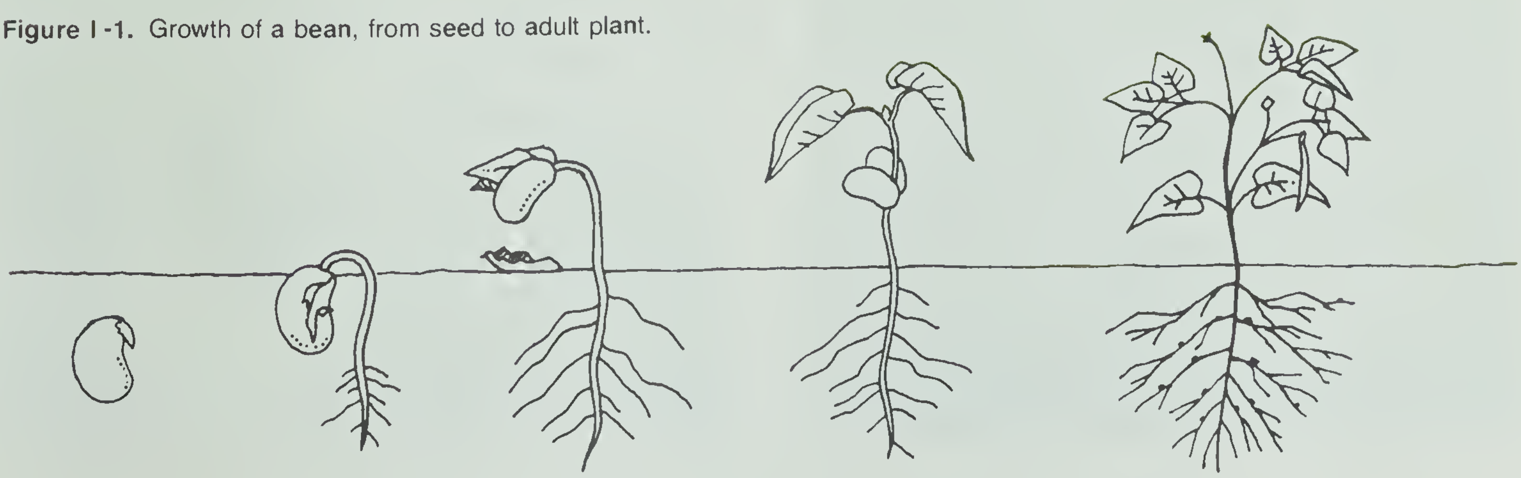
In Chapter 2, "Growing Plants," the children observe the growing plants, note and compare characteristics, and report the results of their experiments. Some children may test to find how varying the amount of light affects plant growth. These activities can be carried out concurrently with the activities in Part Two, or they can be done while you are waiting for the first shipment of organisms. The seeds needed for Part One are in the kit.

GETTING READY

Order the organisms for Part Two in advance, using the form in the Printed Materials drawer of the equipment kit. Order Live Organisms Shipment O-1 three weeks before you expect to do Chapter 3. When you mail the form, record the date on which you expect delivery. Prepare the "aged" tap water about two days in advance of the delivery date.

Before doing any work in the classroom with living organisms, be sure to read "SCIIS Plants and Animals," pages 77-83.

Figure I-1. Growth of a bean, from seed to adult plant.



1 Observing and Planting Seeds

SYNOPSIS

The children observe and describe seeds before planting them.
Seeds are grown in varying conditions.

Suggested time: *one class period*

TEACHING MATERIALS

For each child:

Drawer 1

student manual page 2

For each team of two children:

Drawer 2

2 planter bases
1 tray

Drawer 3

2 pumpkin seeds
2 pea seeds
4 mustard seeds
20 ryegrass seeds
2 planter cups

Drawer 4

1 magnifier

For the class:

1 large wall calendar*
1 bag soil ‡

Drawer 2

2 planter bases
3 water sprinklers

Drawer 3

4 pumpkin seeds
4 pea seeds
8 mustard seeds
40 ryegrass seeds
2 planter cups

* provided by the teacher
‡ in Sand and Soil box

ADVANCE PREPARATION

For each team, put two pumpkin, two pea, four mustard, and about twenty ryegrass seeds on a tray. Provide stations in the classroom for the distribution of the planters, soil, and magnifiers.

Each child will need a base and a planter cup. The planter cup has drainage holes in the bottom and fits into the planter base, which collects excess water. The assembly technique is shown in Figure 1-1. You may assemble these in advance, filling the cup up to the frosted rim with soil, or let the children do it themselves.

Figure 1-1. Push the planter cup into the base, then turn until you feel the two parts lock together. The planter-stick holes will now be aligned.

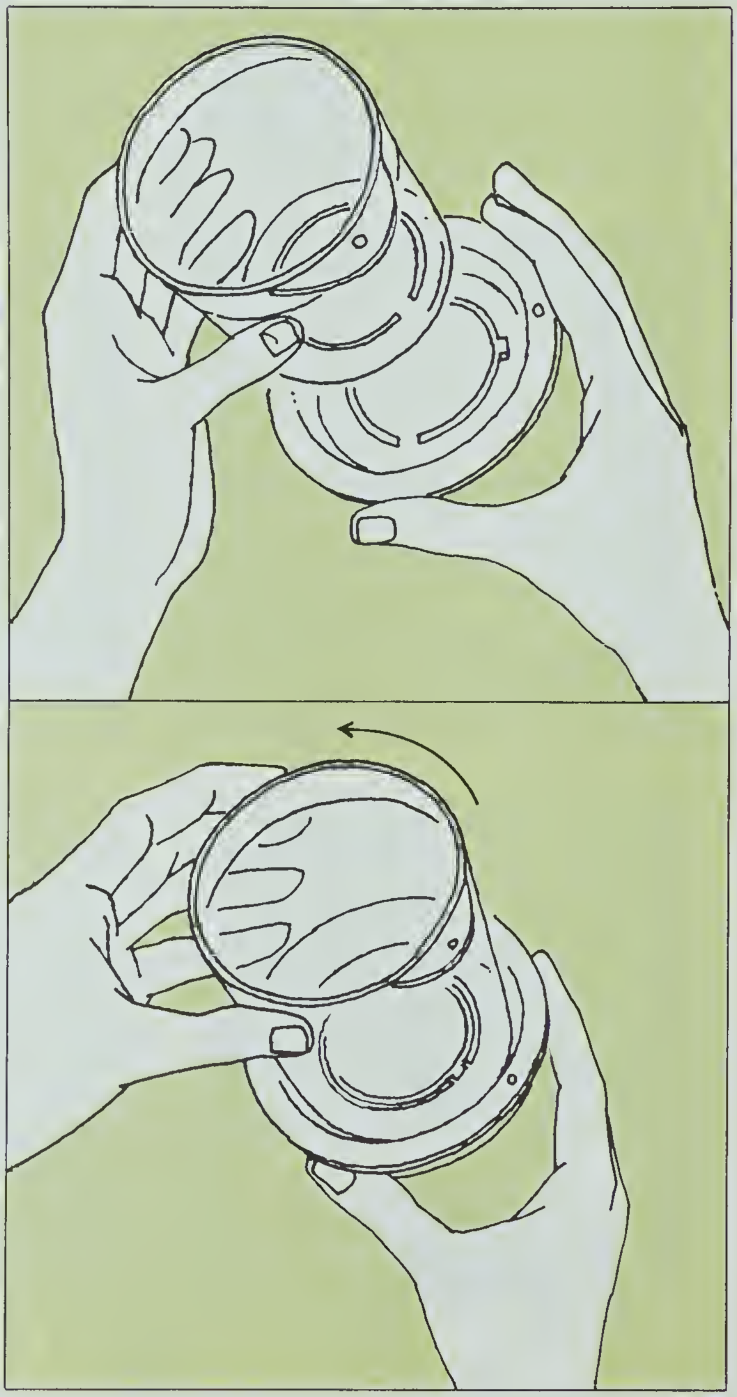


Figure 1-2. Children can bring an object into focus either by moving the magnifier back and forth or by moving the object while holding the magnifier still.

TEACHING SUGGESTIONS

Have your pupils begin the unit with this exploration activity, in which they examine seeds and test conditions for seed growth.

Observing seeds. The children should work in pairs. Give each pair a magnifier and a tray containing the four kinds of seeds. Ask the children to observe the seeds with their magnifiers, using the methods shown in Figure 1-2, and to sort the seeds into groups. The seeds in each group should have the same characteristics. Extending Your Experience card 1, Seeds and Properties, provides practice in describing characteristics of seeds and other objects.

Using student manual page 2. You may have to remind the children to write their names on the manuals. When the children have finished sorting the seeds, have each child plant some large and some small seeds, such as pumpkin and ryegrass, or pea and mustard. As they choose seeds to plant, have them circle the corresponding pictures in the student manual.

Planting seeds. Distribute the planter cups and soil. Show the children how to plant the pumpkin seeds and pea seeds by dropping one seed into a hole about 2 cm (¾ in) deep and covering it with soil. The seeds should be spaced well apart. Mustard and ryegrass seeds can be sprinkled on the surface and then covered with a thin layer of soil.

Have the children label their planters with their names. They can write in pencil on the frosted rims of the planter cups.

2 Chapter 1

Which seeds?
Put rings around them.

When will you water your plants?
Make an *X* each time.

	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Week 1							
Week 2							
Week 3							
Week 4							

Watering. After all the seeds have been planted, ask the class how often the seeds should be watered. On the basis of the responses, divide the class into at least two groups—one recommending frequent wa-

Figure 1-3. Push a pencil 2 cm into the soil, drop the seed in, and cover the seed with soil.

tering, the other only occasional watering. If some children suggest an intermediate schedule, let them form a third group.

Arrange the planters according to the watering schedule—the planters to be watered frequently in one group, those to be watered less often in another group. Place all planters where they will receive light—near windows or a lamp. Be careful, however, not to place them too near radiators or in other hot areas.

Using student manual page 2. You can schedule the watering times for all groups on a large wall calendar (Figure 1-4), and the children can make *X*'s in the proper squares of the student manual calendars each time they water the plants. (You may want them to fill in the actual month and date as well.) Each child should have the responsibility of watering the group's plants at least once.

Try to keep the children on their original schedule. You may find this difficult. For example, children who decided to water the plants infrequently may change their minds if their seedlings begin to wither. If this happens, let them change their schedule—but only after they give reasons.

To ensure that the class will have some healthy plants to observe at the end of the experiment, plant some seeds of each kind in two planters yourself. Check them three times a week and add water if the soil feels dry. Give them enough water to wet the soil thoroughly but stop if you see water draining into the planter bases. (You can more easily correct underwatering, if necessary, than overwatering.)

When seedlings appear, move on to Chapter 2.

OPTIONAL ACTIVITIES

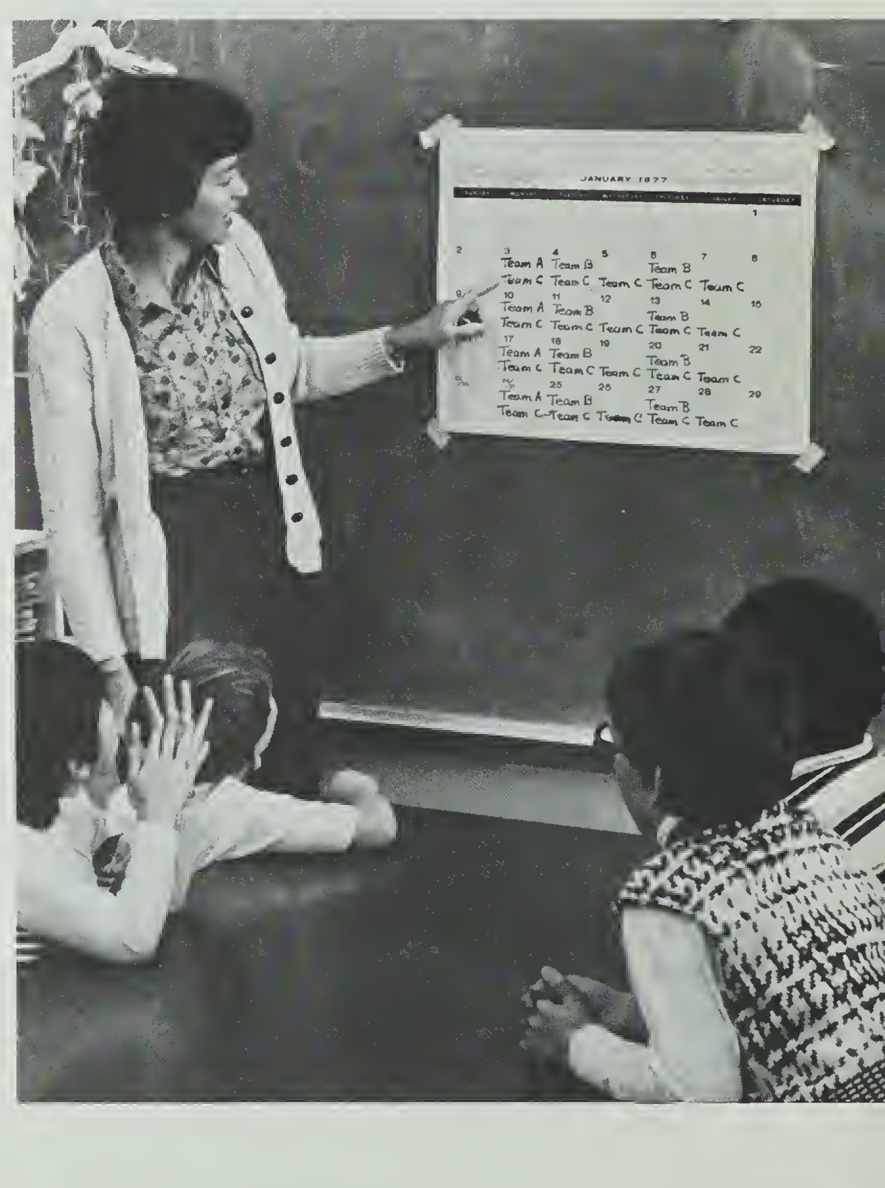
Use extra planters and seeds for these activities, recording the names of the seeds and the depths of planting on the frosted rims. If you run out of planters, use milk cartons, aluminum muffin tins, or cupcake liners with glued labels. Ample amounts of seeds and labels have been provided in the kit. You may wish to set up activities designed to answer the following questions or other questions the children ask:

Will a seed grow in water only? Put some seeds in a tumbler and cover them with water. Leave the setup for about a week, replacing water that is lost by evaporation.

Will a seed grow "upside down" or on its side? Plant seeds of the same kind in various positions, labeling the planter cups with pictures showing the positions.

Will a cracked or broken seed grow? Find cracked seeds in the packet or crack some yourself.

Figure 1-4. Planning watering schedules for three teams.



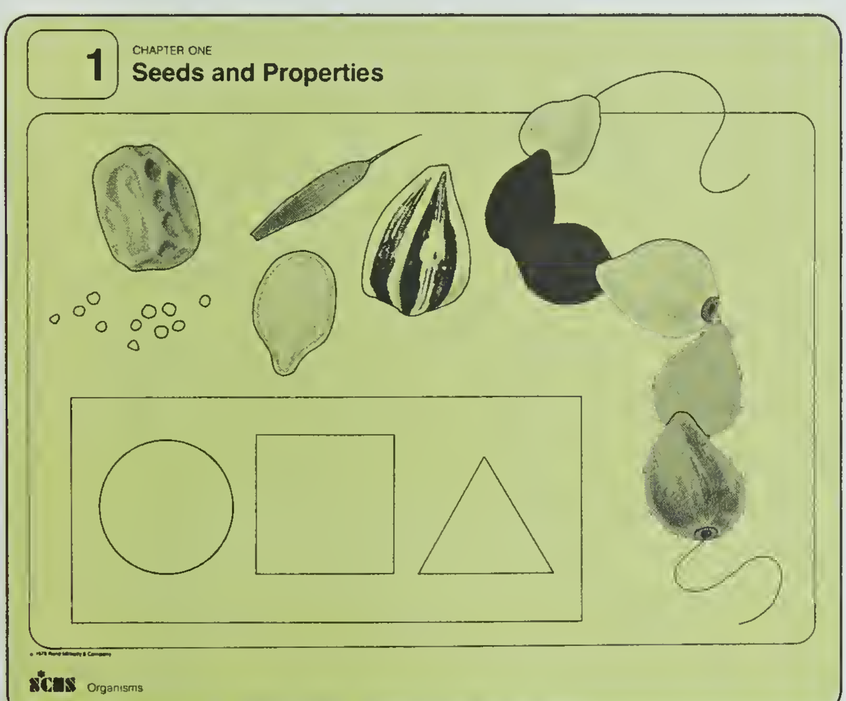
Will a seed grow in sand or a wet sponge? Put sand or a sponge in the planter cup and plant seeds in it. Water thoroughly.

Will soaked seeds grow faster? Soak some seeds overnight. Have children plant those seeds, and unsoaked seeds of the same kind, in labeled planters, containing moist soil. From then on, both groups of seeds should be watered as usual.

EXTENDING YOUR EXPERIENCE CARDS

For suggestions on using these cards, see page xvii.

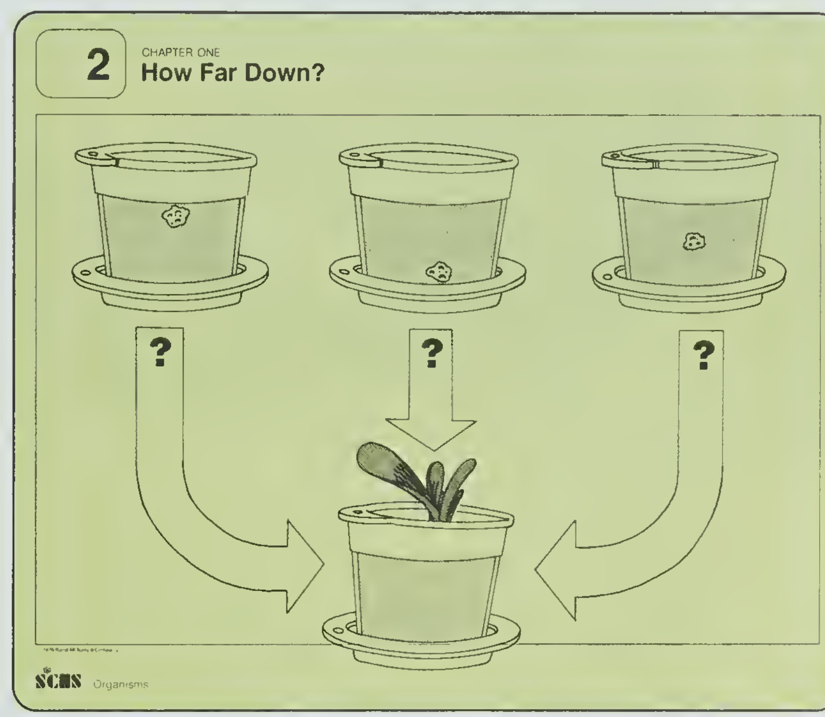
1. Seeds and Properties. Have the child describe to you the properties (characteristics) of the seeds and geometric shapes on this card. Ask questions about size, shape, color, and texture. In addition to facilitating the work with seeds, this card enables you to determine whether the children can use and understand basic property words.

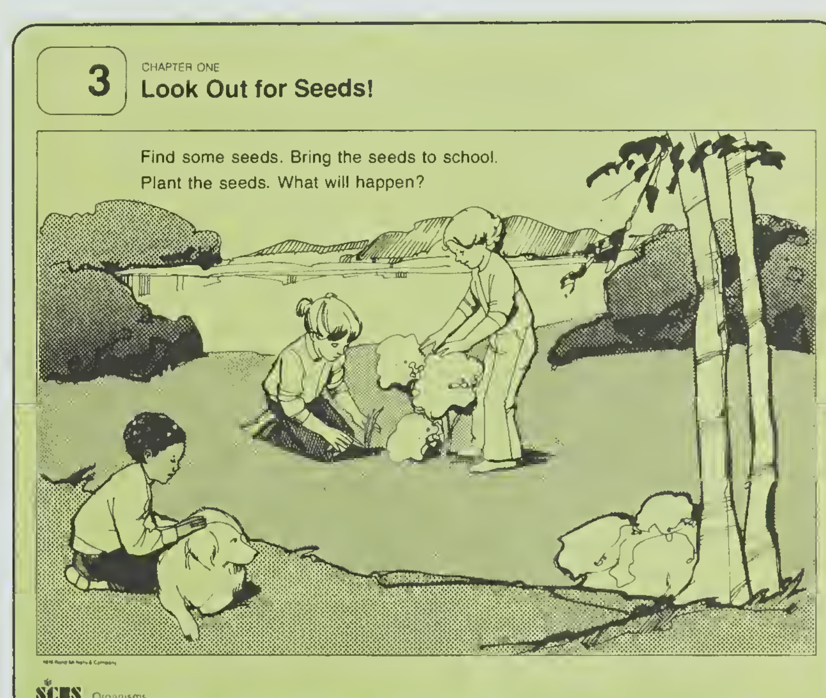


2. How Far Down? Have the child plant seeds at three different depths, including a depth of 2 cm (¾ in).

3. Look Out for Seeds! The child is to look for seeds in a field or vacant lot near the school. If such a trip is not feasible, encourage the child to explore areas around home.

Any seeds, or objects the child thinks are seeds, may be brought to class and planted. Each planter should contain seeds of one kind only, and one of the seeds should be taped to the outside of the planter for identification. (If no extra seeds are available, the child can draw pictures of the seeds planted.)





4. Shopping for Seeds. Have the child visit a local supermarket (with an adult) to find seeds on the shelves where spices, nut meats, cereals, dry beans, and pet foods are stocked. The produce counters should provide examples of fresh foods containing seeds. You may also suggest searching for seeds in kitchen cupboards.

2 Growing Plants

SYNOPSIS

Children observe and report on their plants from day to day.
They learn that growing plants need light and water.

Suggested time: ***several weeks***

TEACHING MATERIALS

For each child:

student manual page 3

For the class:

seedlings (from Chapter 1)

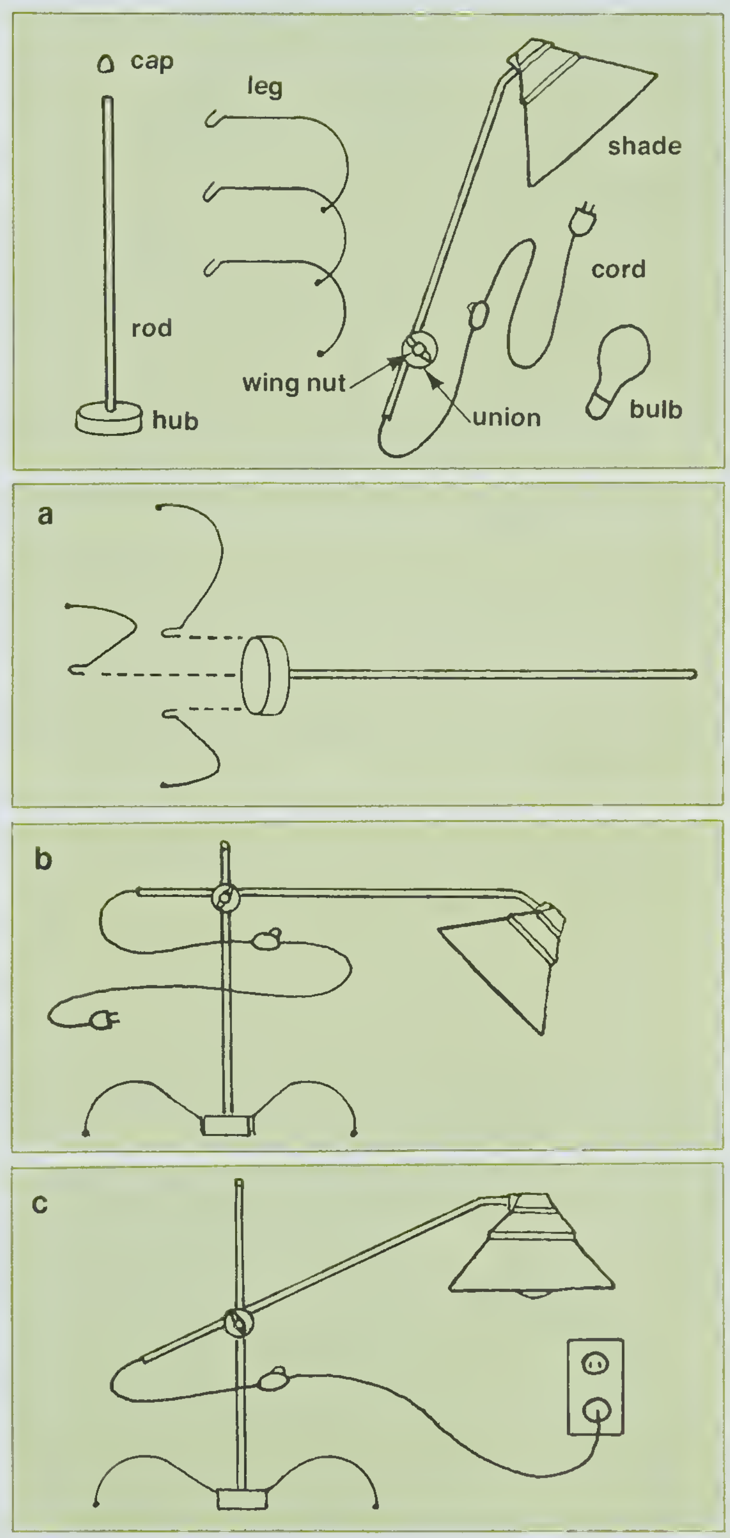
Drawer 1

light source

ADVANCE PREPARATION

You will find a light source partly assembled in the kit. Use the instructions in Figure 2-1 to complete the assembly before beginning this activity.

Figure 2-1. *(a)* Firmly push the legs into the bottom of the hub. Set this assembly upright. *(b)* Unwind the cord, loosen the wing nut, and push the rod through the union. *(c)* After lowering the union and rotating the arm, tighten the wing nut. Keep the bottom of the shade parallel to the table. Cap the rod and add the light bulb.



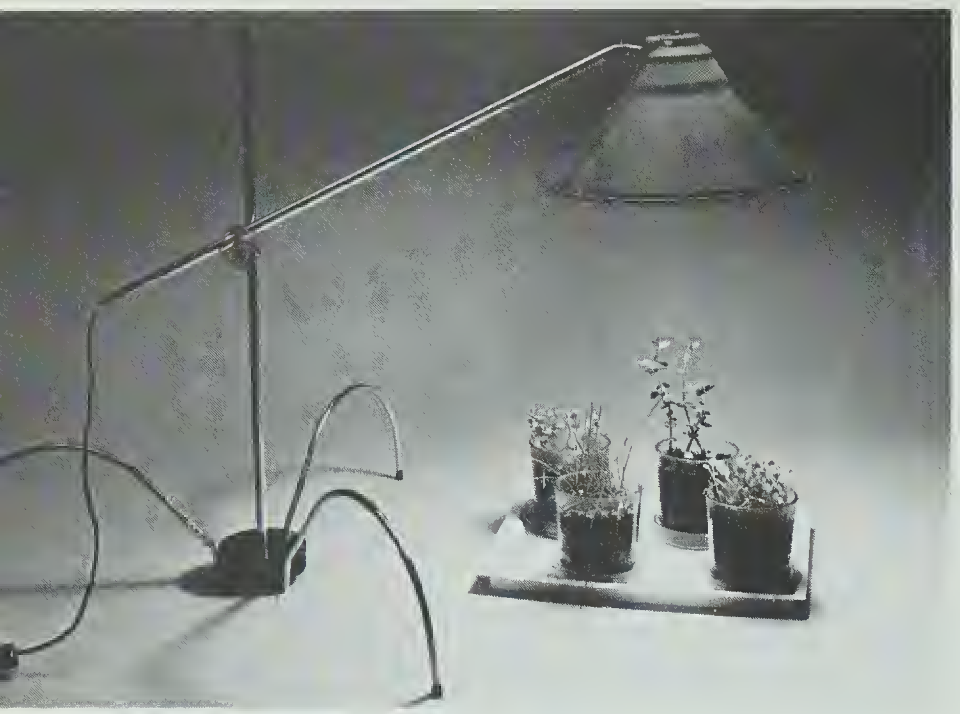


Figure 2-2. The seedlings' characteristics—height, leaf shape, stem thickness, color, and so on—can be compared.

TEACHING SUGGESTIONS

The exploration part of the learning cycle begun in Chapter 1 is continued.

Using the light source. Place the planter cups around the base of the light source when the seedlings break through the soil. Leave the light on only during the day. However, if your classroom is very cold over the weekend, leave the light on continuously from Friday until Monday.

Using student manual page 3. When some seedlings have emerged from the soil, have the children draw pictures of the plants in their manuals.

- Then ask, "Which type of seed sprouted first? Which plants seem to be growing fastest?"
- Encourage the children to compare the different kinds of plants and to circle the picture of the kind of seed that has so far produced the tallest plant.

Observing growing plants. When the children report the results of their watering experiments, stimulate a discussion:

- Ask, "What happened to the plants that were watered least?" "What happened to the other plants?" "How much water is best for these plants?"
- Draw a blank calendar on the chalkboard and, using the records of teams having the best results, put *X*'s in the squares representing the best watering sequence.

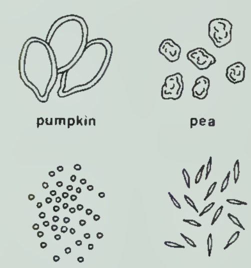
Using student manual page 3. The children can record the class results on their own calendars. These results may be compared with the "best" sequence predicted on page 2.

- If the children carried out any other experiments, they should report their results and conclusions.
- Invite the children to name the plant parts they know.
- If the children wish to examine the roots, let them pull a plant out of the soil. If they are too protective of the plants to do this, use one of your plants.

Chapter 2 3

Which plant is tallest?

Draw a ring around the seeds.



Draw a picture of the plant.

How often were the tallest plants watered?

Make an *X* each time.

	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Week 1							
Week 2							
Week 3							
Week 4							

Light. If the seedlings bend toward the light, call this to the children's attention and ask them if they have any ideas about what caused the plants to bend. If they suggest light, ask them if they can describe a way to straighten the plants without touching them. If the planters are turned so the plants bend away from the light, they will soon straighten up. The children may offer other ideas about the cause; if possible they should test these ideas experimentally.

Are plants alive? If this question is asked, let the children discuss their ideas. However, do not expect a definite answer, because the children's knowledge is probably not adequate to deal with the question.

Figure 2-3. Plants bending toward the light source.

OPTIONAL ACTIVITIES

Optional activities may be devised from questions such as these.

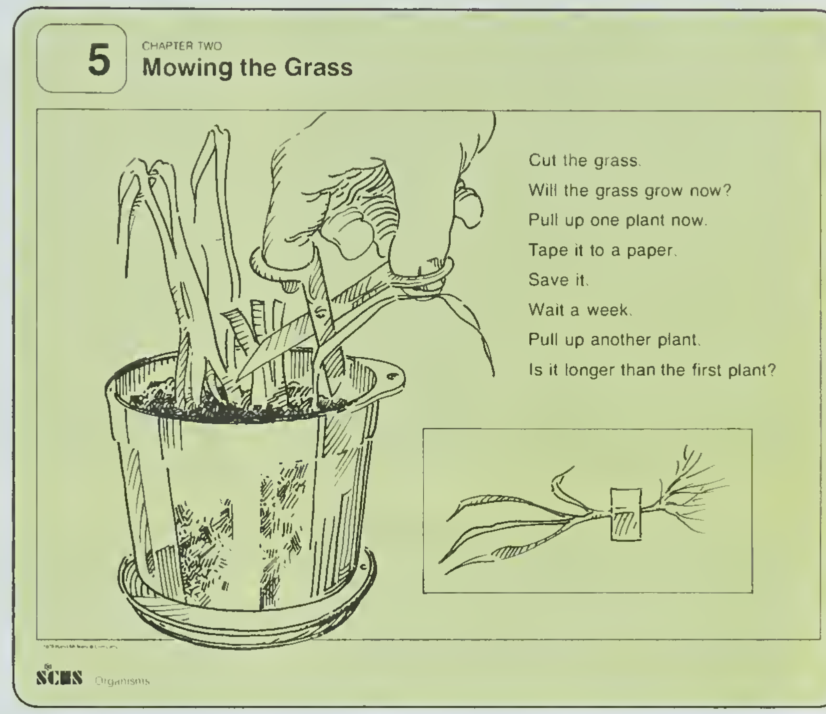
Will an outdoor plant grow indoors? Outdoors, find a small, common plant that has recently emerged from the soil. Bring it into the classroom and plant it.

Will these seeds grow only in our classroom? Take two seeds home and plant them.

Cleanup. When the activity is concluded, some children may want to take their plants home. To accomplish this, transfer the plants (including the soil surrounding the roots) into milk cartons or other containers. Wash the planter cups and bases and store them for later use.

EXTENDING YOUR EXPERIENCE CARDS

5. Mowing the Grass. The card user should plant some grass seeds in a planter. When the grass is about 5 cm (2 in) high, it should be cut off evenly at about 2 cm (¾ in) above the soil. One plant can be uprooted at this time and taped to a piece of paper for later comparison. A week later, another plant can be compared with the uprooted plant.

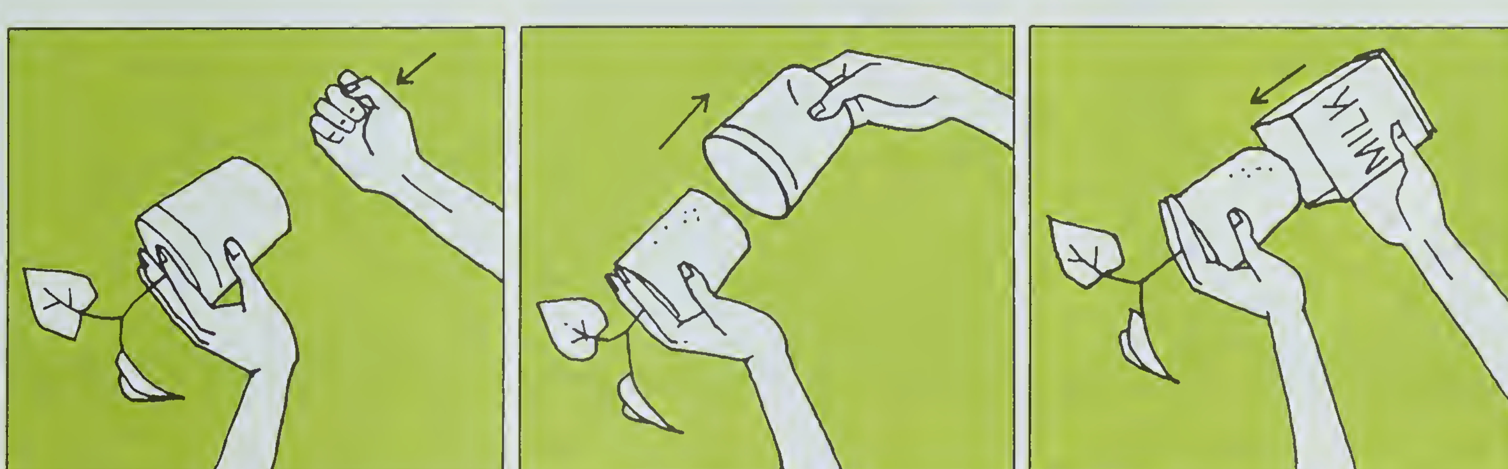


Extending Your Experience cards 1–5 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of the requirements for plant growth, turn to page 67 of the evaluation section.

Figure 2-4. Hold the plant as you strike the planter cup. Lift the cup off and replace it with a new container.



Part Two

Classroom Aquariums

OBJECTIVES

To recognize and describe birth, death, feeding, growing, and other events in the aquariums.

To use the word *organisms* for plants and animals.

BACKGROUND INFORMATION

The following organisms have been provided for your class aquariums:

Ceratophyllum, or hornwort, is a plant that floats beneath the water surface in ponds and lakes. A piece of broken-off hornwort will become a large plant.

Sagittaria is a highly variable group of rooted, fresh-water plants. The species in your aquarium is a dwarf species having ribbonlike leaves.

Duckweed, a tiny flowering plant, often forms a green mat on the surface of a pond or slow-moving stream.

Water snails glide along plants, rocks, and other submerged objects. Small ones sometimes hang from the surface film of water.

Guppies are small tropical fish. Female guppies are usually larger and grayish in color, while the males are smaller and very colorful in most cases. Young guppies are born alive.

The SCIIS algae are single-celled green plants. The individuals are microscopic in size. However, if many individuals are present—as may happen in an aquarium—the water becomes green.

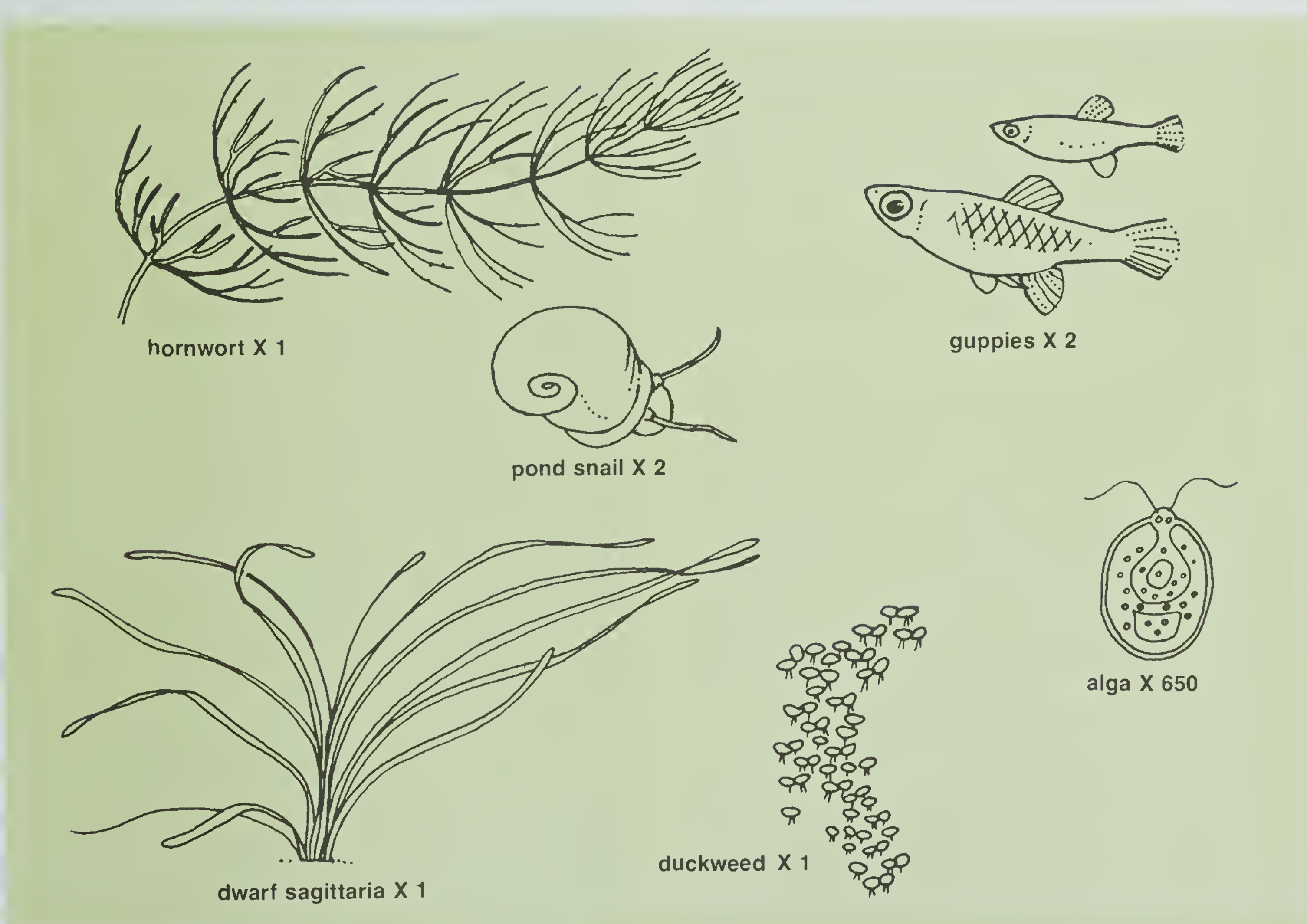


Figure II-2. A habitat board in place.

The appearance of green water in the classroom aquariums is intended to pose a problem for the children. Algae can be found almost everywhere, and it is almost certain that your aquariums would contain algae even without your adding them. However, the addition of algae is good insurance.

More information on the organisms in this unit is in the "SCIIS Plants and Animals" section (page 80).

OVERVIEW

The children set up aquariums, then observe and report on the events that occur in the aquariums during the weeks following. Many of these events are the subjects of chapters in this unit.

The term *organism* is invented in Chapter 3, "Building and Observing Aquariums." In Chapter 4, "Male and Female Guppies," the children will distinguish between male and female guppies. In Chapter 5, "Birth and Growth of Guppies and Snails," they observe young guppies and snails, and you invent the concept *birth*. The concept *death* is invented in Chapter 6, "Death in an Aquarium," after the children see the decay of an organism.

If nothing significant happens in the aquariums and the children ask no questions during the first week, proceed to Part Three. Keep observing the aquariums, however, for some changes that will interest the children are bound to occur.

GETTING READY

You will need extra "aged" tap water for the activities using aquatic plants and animals. Directions for aging water are on page 77. Or, you may use bottled spring water instead. Store it in large containers (such as those in which bottled water is sold) so it will be available when you need it. Do not store the water in containers that have been used for bleach, ammonia, or other household chemicals.

At this time, set out a "habitat board" for use in Chapter 8. Obtain a flat, square wooden board of any size that you or the children can easily handle but at least 25 centimeters—about 10 inches—on a side. Place it where the children can visit it easily but where it otherwise will be left undisturbed. For best results, place it:

- in an area that is shaded during at least part of the day
- on a flat surface
- on grass or rich soil, rather than sand or clay

3 Building and Observing Aquariums

SYNOPSIS

Children observe aquatic plants and animals, then use them in setting up classroom aquariums.
You invent the term organism.
Some aquariums are placed in light areas, others in the dark.
In the weeks following, changes in the organisms are seen.

Suggested time: *two class periods, followed by several weeks of observation*

TEACHING MATERIALS

For each child:

student manual page 4

For each team of two children:

several duckweed plants†
1 pond snail†
1 guppy†

Drawer 4

1 plastic tumbler
1 magnifier

For each team of five or six children:

4 cups white sand‡

Drawer 4

1 six-liter container

For the class:

green algae†
hornwort†
duckweed†
dwarf sagittaria†
snails†
guppies†
1 bottle plant minerals†
1 carton fish food†
crayons*
several containers for aged tap water*

Drawer 2

1 light source

Drawer 4

1 dip net (coarse mesh)
1 six-liter container

Drawer 5

3 fluted containers
1 medicine dropper

* provided by the teacher
† in Shipment O-1
‡ in Sand and Soil box

ADVANCE PREPARATION

With the help of the children, prepare seven aquariums two or three days before the organisms arrive (shipment O-1).

Begin by rinsing the sand. To do this, place about 4 cups of sand in each empty aquarium. Pour water into the aquarium and stir. Let the sand settle, then pour off the water along with the floating material. Repeat this until the water remains clear after stirring, with no floating material. Add water up to the frosted area at the top of the aquarium. Then set the aquarium aside for at least two days before adding organisms. During standing, the water becomes "aged": the chlorine in the water is reduced below the level harmful to aquatic organisms. (If you prefer, you may use bottled spring water available in grocery stores.) Age about 15 extra liters (4 gallons) of tap water and keep it for future use.

Receiving the organisms. When shipment O-1 arrives, immediately open the jar of green algae and place it where the children cannot see it. (After the other organisms have been added to the aquariums and the class has left the room, you will add algae secretly to each aquarium. This is done to ensure the appearance of green water in some of the aquariums for the Part Four activities.)

Lower the guppy shipping container into an aquarium in which tap water has been standing for at least two days. After one or two hours, when the contents of the shipping container are at aquarium temperature, pour the contents through a dip net; discard the liquid. Add half the guppies to one container and half to the other, making certain that both sexes are present in each container (males and females are pictured on page 20). The guppies will be caught in the dip net and can be transferred to two containers of aged tap water. Be sure to carry out the transfer within a few hours of receiving the guppy shipment. Add several pieces of hornwort to each container. If guppies are not distributed to the children within three or four days, add daphnias or the fish food provided in the kit.

The jar containing duckweed should be opened on the arrival day. Unopened bags of sagittaria and hornwort can be placed in a cool area until needed. If pond snails are shipped in the same bags, however, these bags also must be opened on the arrival day.

TEACHING SUGGESTIONS

Exploration activities with various plants and animals lead to invention of the concept *organism.*

Observing organisms. For each pair of students, half fill a tumbler with aged tap water. Using the dip net, add a guppy and a snail to each tumbler. Dip a finger

into the duckweed. The plants that cling to the finger should be added to the tumbler.

Distribute the tumblers and have each child look at the animals and plants with a magnifier as you write the organisms' names on the chalkboard.

What to look for. To direct the children's observations, suggest that they look for answers to these questions:

- Is any part of the snail outside its shell?
- How does the snail move?
- Does the snail swim in the water?
- Does the guppy swim in the water?
- How does the guppy move?
- How many fins does a guppy have? Where are they?
- What do the fins do?
- Can you see the guppy's mouth?
- Do guppies have ears?
- Where are the duckweed plants?
- Do the duckweed plants move around, as the snails and guppy do?

Discussion. After ten to fifteen minutes of observation, gather the children for a discussion. Repeat the questions. If the children disagree about the answers, ask them to look at the organisms again.

Replace any aged tap water that spilled from the tumblers, then put them aside until the next day.

Figure 3-1. Let the children observe the guppies, snails, and duckweed at close range.

Adding organisms to the aquariums. On the day after they have observed organisms in tumblers, tell the children that they will add the plants and animals to their aquariums.

Group the children into teams of five or six. Give each team two or three of the tumblers and an aquarium containing sand and aged tap water. Tell the children to pour the contents of the tumblers into their aquariums. Save one aquarium for use as an algae culture and label it Algae. You will need it in Chapter 11; in the meantime, put it where it will receive light but not where the children will see it (perhaps in another classroom).

Before distributing the sagittaria and hornwort, write the names of these plants on the chalkboard and show the children which plant is which. Give each group two sprigs of sagittaria and tell the students to gently poke the roots into the sand. Break the hornwort up as needed and give the groups equal amounts of it. Have them drop the plant into the water. Distribute the remaining snails, duckweed, and guppies equally among the groups. The snails and duckweed may be simply dropped into the water. Use the dip net for the fish, making sure there are both males and females in each aquarium.

Using a medicine dropper, add twenty drops of plant minerals to each aquarium. (Make a note to add another twenty drops a week from now.) This will provide minerals necessary for plant growth.

Have each group write its team name or number on the frosted area on the aquarium.

Use aged tap water to keep each aquarium filled.

Placing aquariums. Place the aquariums in different parts of the classroom, where the children can easily gather around them. To promote the growth of algae and the appearance of green water, be sure that three of the aquariums are near a window or under the light source. The other three should be in a darker part of the room. Avoid placing any aquariums too near radiators, in direct sunlight, or directly beneath the light source, where the water might become too hot for the organisms.

Using student manual page 4. Have the children draw pictures of the aquariums. Some children will be able to write their own labels; others can circle the names given in the manual. Ask them why caterpillars would not be placed in the aquariums.

Feeding guppies. These fish ordinarily feed on small aquatic organisms, but in an aquarium they will eat dried fish food. Let the children feed the guppies but stress that a tiny bit of fish food two or three times a week is adequate. Give the carton of food one quick shake. Do not use more; uneaten food can contaminate the aquariums.

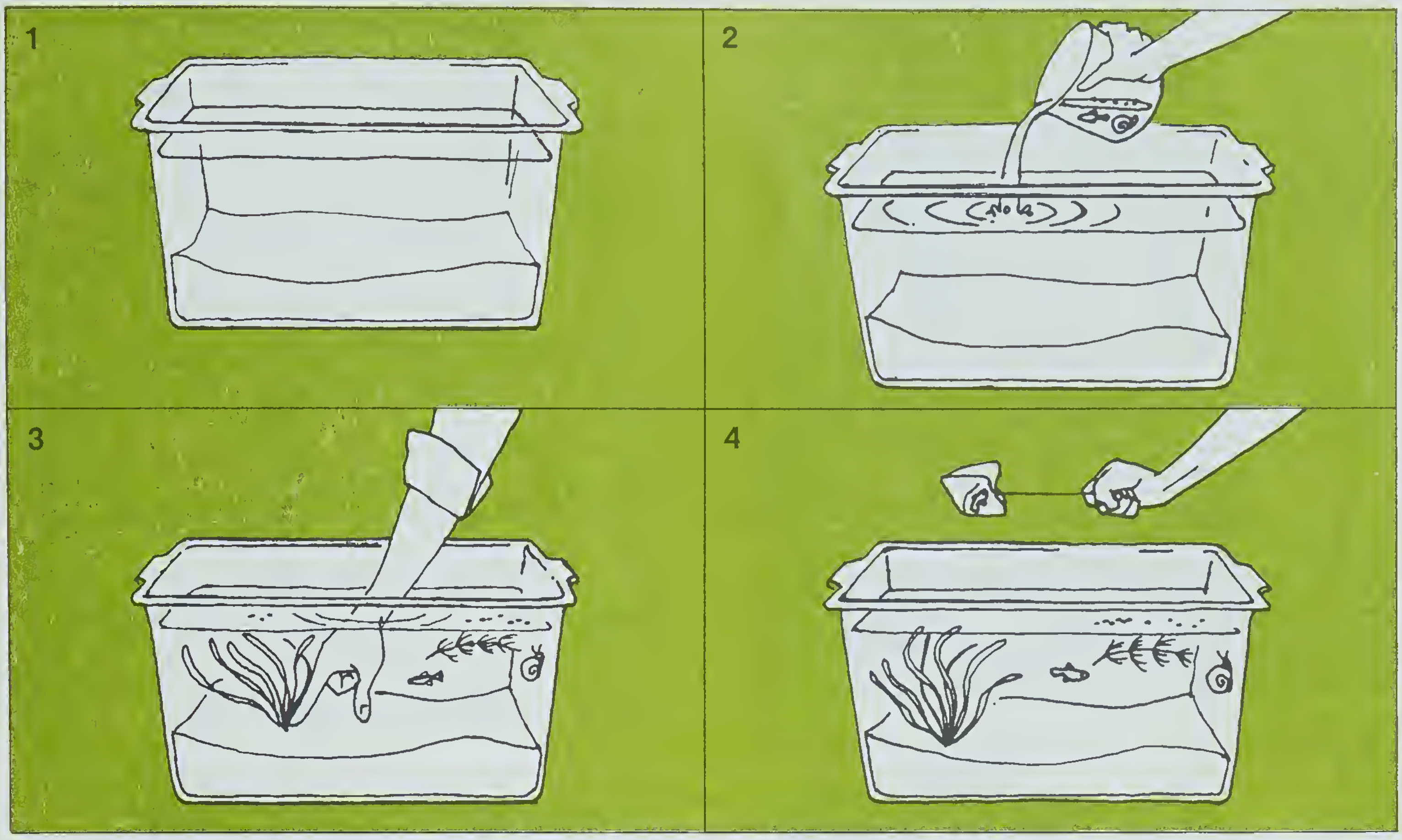
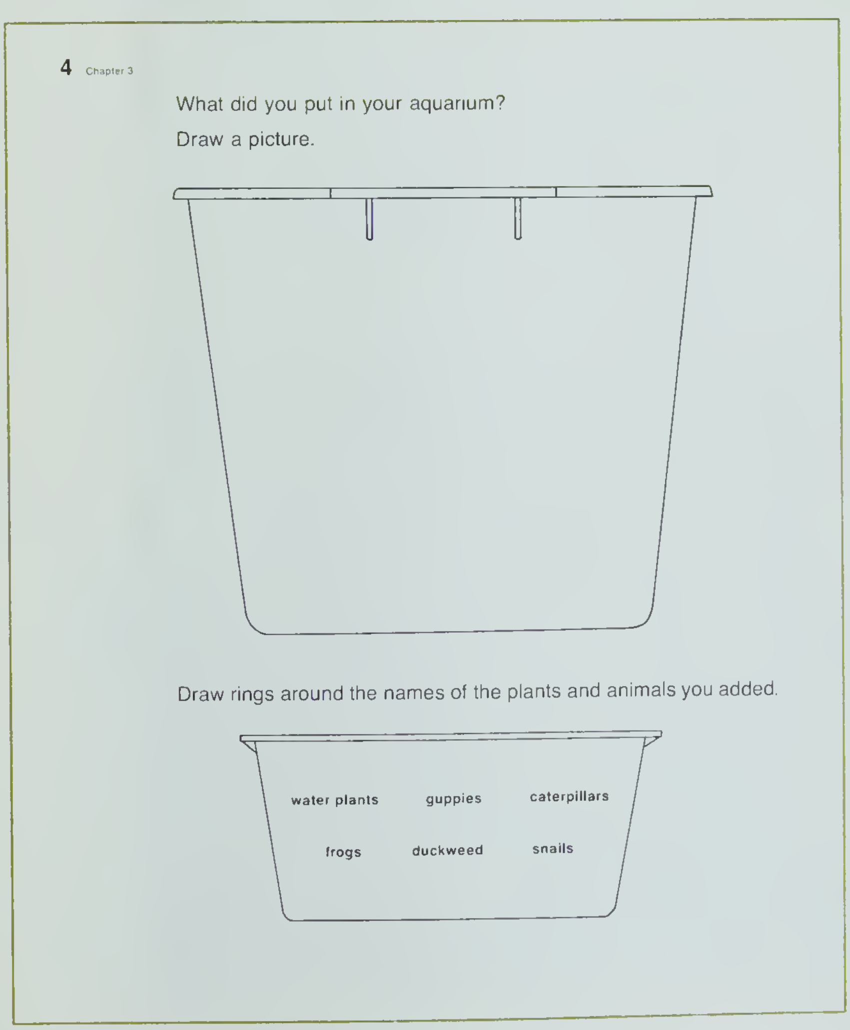


Figure 3-2. Setting up an aquarium.


4 Chapter 3

What did you put in your aquarium?

Draw a picture.

Draw rings around the names of the plants and animals you added.

water plants guppies caterpillars

frogs duckweed snails

Adding algae. After the children have left the room, stir the algae culture to ensure equal distribution of the plants. Then divide the culture into seven equal portions and pour one portion into each aquarium, including the extra one you prepared earlier.

"Inventing" the concept *organism*. The next day, ask the children to name, point at, or otherwise identify the plants and animals in the classroom.

- List the names on the chalkboard.
- Then ask the children to name some classroom objects that are neither plants nor animals.
- Use these names to make a second list.
- After making the lists, ask the children to compare the two groups and to suggest differences between them.
- Do not expect the children to say that the plants and animals are alive, while the other objects are not. At this age, many children are confused about the differences between living and nonliving, and many children do not believe that plants are alive.
- Whatever the outcome of the discussion, say that plants and animals are called *organisms*.
- Write the term *organism* on the chalkboard above the list of plants and animals.
- Then ask the children if they can name some organisms outside the classroom.

Figure 3-3.

Planning ahead. The sequence for the rest of this unit depends on what happens, and when, in your classroom aquariums. Encourage the boys and girls to examine the aquariums briefly each morning and to report any changes in them. As natural events occur, use them as springboards to later chapters or to other activities. The following suggestions are a general guide.

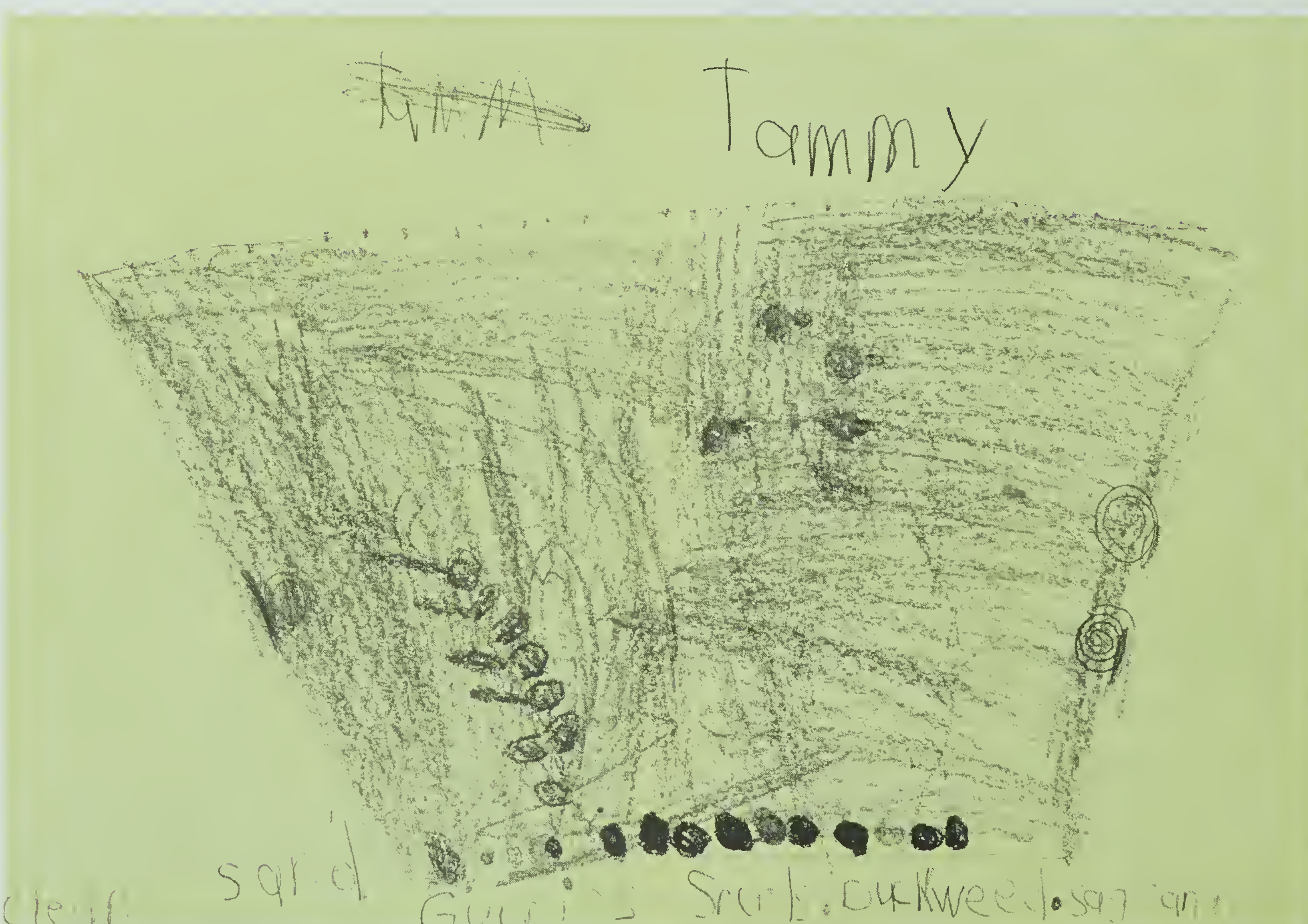
You can begin Chapter 4, "Male and Female Guppies," a day or so after setting up the aquariums. Both males and females are included in your guppy shipment, and so, no special event must precede this activity.

While waiting for results in Chapter 4, have the children skip ahead to Part Three, "Habitats." Part Three can be continued intermittently as other chapters are taught.

When snail eggs or baby guppies appear, begin Chapter 5, "Birth and Growth of Guppies and Snails."

The death of a snail or guppy is your signal to teach Chapter 6, "Death in an Aquarium."

Figure 3-4. Encourage your children to draw pictures of their aquariums. They will observe the organisms more closely.



When you have completed Part Two, you may want to set up a closed aquarium, that is, an aquarium ecosystem that is completely isolated. To do this, take one aquarium containing an assortment of organisms and cover it with a tight lid to prevent evaporation of water. Do not remove the cover to add water, food, or anything else. For a long-lasting aquarium, begin with water that contains algae and several large hornwort plants; add some fish food; then put in two snails and two guppies, male and female; and last, drop several daphnias among the plants. Both you and the children should observe the aquarium occasionally to note any change in the populations of organisms. Keep the aquarium as long as interest remains.

The water in the aquariums placed in the light in Chapter 3 should gradually become green because of the increased numbers of algae. The water in the other aquariums will probably remain colorless. This color change will probably not happen for several weeks. When the children notice it, you may begin Part Four, "Algae."

Start Part Five, "Food Chains," only after Part Four is completed.

The activities of Part Six, "Decay," will probably be last in the unit. Waste material begins accumulating as soon as organisms are put into the aquariums, but it will not become obvious to the children for several weeks.

You may find your children are curious about some aquarium happening that has no corresponding chapter. If so, encourage them to ask questions and to experiment under your supervision. The more flexible you can be in teaching this unit, the more successful it will be.

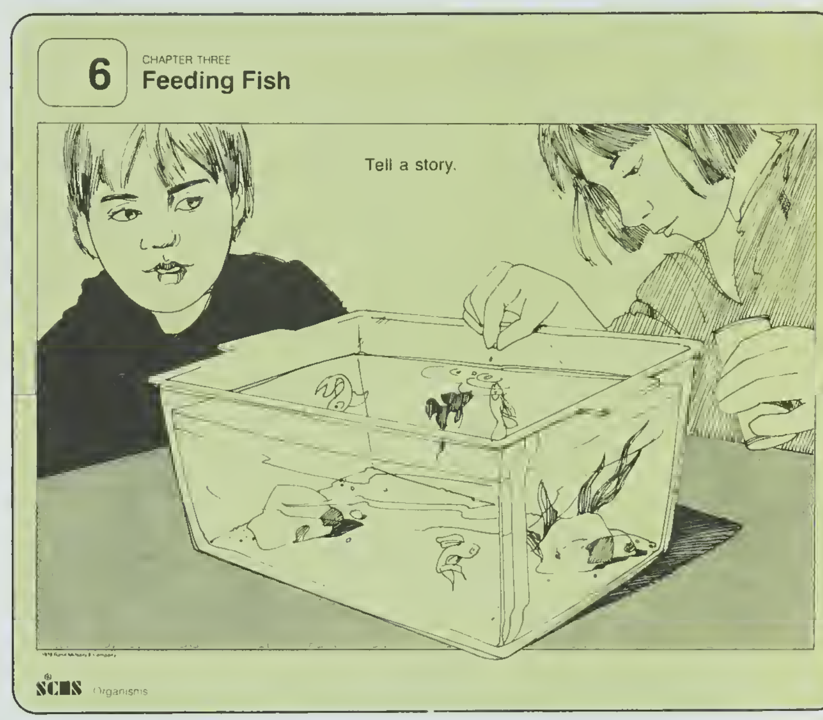
Figure 3-5. A closed aquarium.

OPTIONAL ACTIVITY

What can we put in the aquariums? Children may bring to class aquatic animals and plants from home, pet stores, or other sources. They can set up new aquariums to house these organisms, using empty mayonnaise jars from the cafeteria or other large containers. Do not add other organisms to the seven class aquariums, as the results might affect activities in future chapters.

EXTENDING YOUR EXPERIENCE CARDS

6. Feeding Fish. Ask the children to look at the picture and tell or write a story about it.



4 Male and Female Guppies

SYNOPSIS

To identify male and female guppies, the children separate the two types and watch to see which kind has young.

Suggested time: *one class period to set up, followed by a waiting period of days or weeks*

TEACHING MATERIALS

For each child:

student manual page 5

For the class:

6 aquariums (prepared in Chapter 3)
1 carton fish food†

Drawer 2

1 light source

Drawer 4

1 dip net (coarse mesh)

Drawer 5

2 fluted containers

† in Live Organisms Shipment O-1

ADVANCE PREPARATION

Be sure you have several liters of aged tap water.

TEACHING SUGGESTIONS

The following extended activity involves the exploration phase of the learning cycle.

Separating males and females. The children may notice that some guppies differ from others. If they do not, suggest that they look for differences. (The males are smaller, more colorful, and have spines on their anal fins. Females are larger, grayish in color, and have large black spots on their abdomens when they are about to bear young. Males show up better in dim light.)

- If the children do not suggest that one kind is *male* and one kind is *female*, tell them.
- Then ask how they can tell which is which. Encourage the children to discuss the problem and to propose ways of finding a solution. (You may have to suggest that if a guppy has babies, it must be a female.)
- If no one suggests separating the male and female guppies, you do so. Ask how separating the males and females might help in finding out which is which.

Figure 4-1. Male *(above)* and female *(below)* guppies.

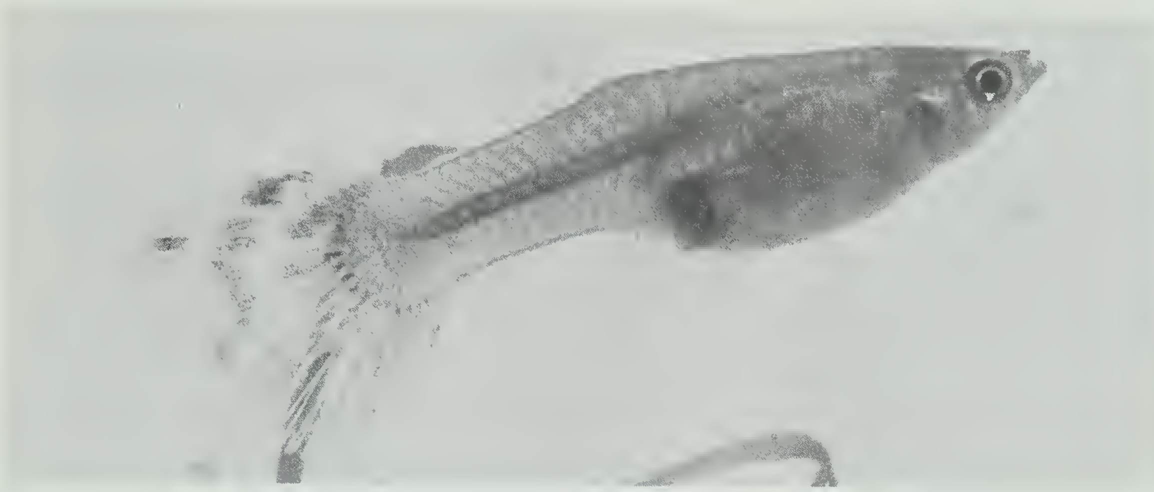


Figure 4-2. A female guppy just before giving birth.

Set up the experiment as follows:

- Fill two containers with aged tap water.
- Using the coarse dip net, add about eight females to one and about four males to the other.
- Add some hornwort and duckweed to both containers.
- Place them near a light source where the temperature is about 25°C (75°F).
- Add a small amount of food two or three times a week.

Baby guppies may appear a day, a week, or several weeks after the adults arrive in your classroom. It is not possible to predict exactly when guppies will be born; if you see a female with a swollen abdomen and a dark spot on each side, you know that babies will arrive soon.

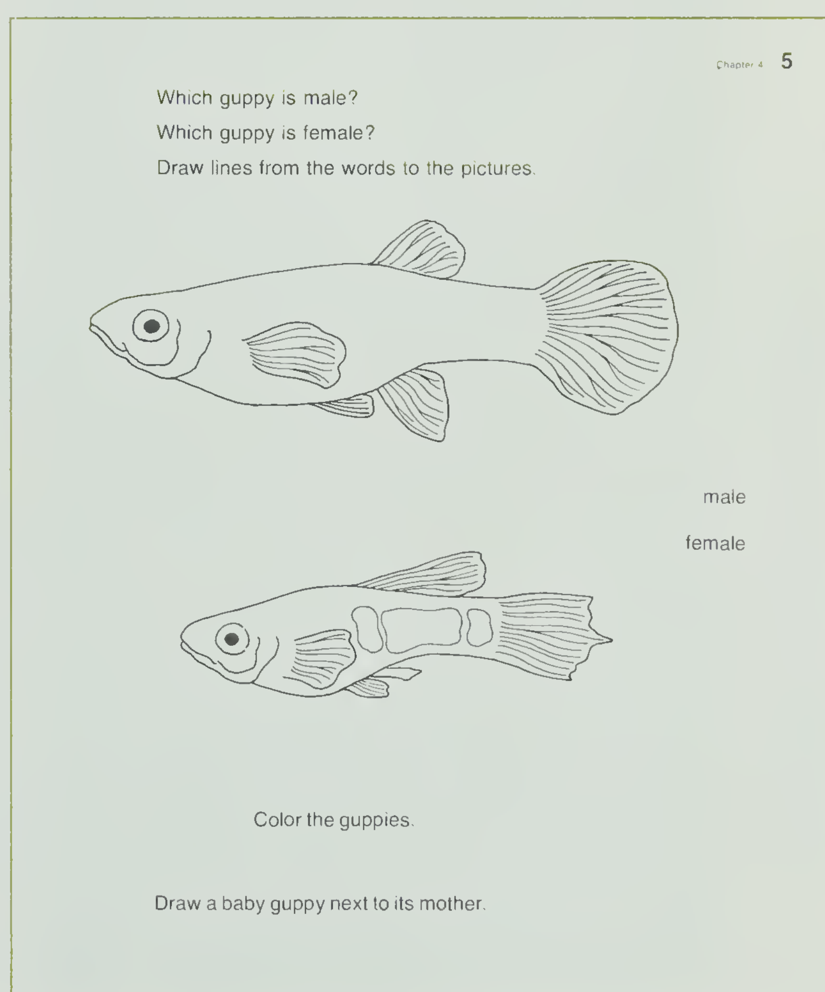
After birth, the adult guppies may eat the young. Therefore, as soon as the children have seen the young in the aquarium, add at least three pieces (about 45 cm, or 18 in, total) of hornwort to the adults' aquarium to give the young a place to hide.

Discussion. After the children have observed the appearance of young, ask them if they now can tell which adult guppies are male and which are female. Also ask for reasons for their decision.

Using student manual page 5. Have the children draw lines from the Male and Female labels to the pictures. Also, ask them to draw a young guppy next to its mother.

Ask the children if they can tell which are male and which female in other organisms. On what basis?

When this activity is finished, or whenever young guppies or snails appear in the class aquariums, continue the children's exploration of birth with Chapter 5, "Birth and Growth of Guppies and Snails."



5 Birth and Growth of Guppies and Snails

SYNOPSIS

The children discover young guppies and snail eggs in the aquariums.

After their initial observations, the children periodically observe growth and development in the young guppies and snail eggs.

You invent the concept birth.

Suggested time: *one or two class periods*

TEACHING MATERIALS

For each child:

student manual page 6

For each team of two children:

1 magnifier

For the class:

6 aquariums (prepared in Chapter 3)
2 containers of guppies (prepared in Chapter 4)
1 carton fish food†
crayon*

* provided by the teacher
† in Live Organisms Shipment O-1

TEACHING SUGGESTIONS

Further exploration activities lead to invention of the concept *birth.*

Guppies. On the day the guppies are born, ask the children to compare the baby guppies' size with that of the adults.

- Ask if they think the young guppies will grow to be as big as the adults.
- Also ask the children if all newborn animals are at first smaller than their parents and then grow until they are adult size. How about themselves? Are they smaller than their parents? Will they also grow?
- Let the children feed the young guppies. A tiny amount of food given two or three times weekly is sufficient.

Snail eggs. Clusters of pale yellowish, transparent spheres, each the size of a pinhead, may appear on the sides of the aquariums and on plant leaves.

- The children probably will not realize that these are snail eggs. Let this remain a mystery.
- Instead of telling the children what the eggs are, let them speculate. Have them observe the spheres daily.
- Using a crayon, make a circle on the outside of the aquarium to indicate where the eggs are. Or, if the eggs are on a leaf, move the entire leaf to a smaller container where the eggs can be inspected more closely.

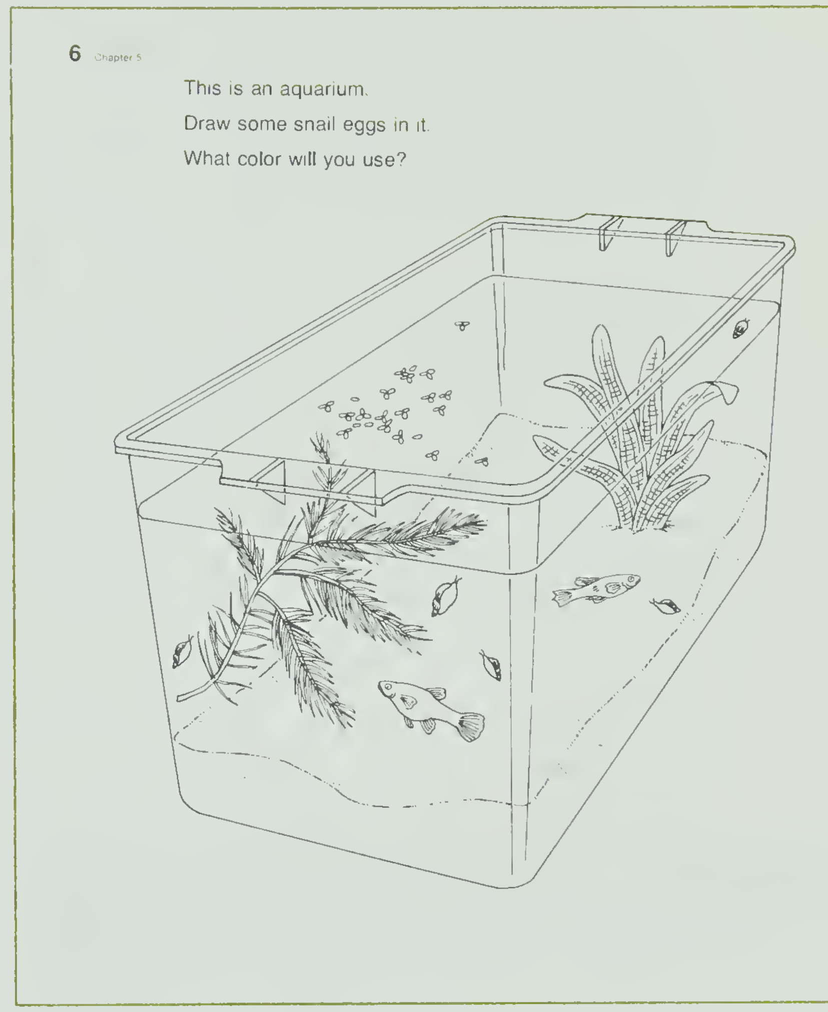
Figure 5-1. Snail eggs attached to hornwort.

- The children should use magnifiers for observing the eggs.
- Eventually a small, brown, opaque spot will appear in each sphere, becoming larger day by day. After a week or two, a small snail will hatch.
- The children probably will not see the hatching, but they may notice that the dark spots in the egg cluster have disappeared.

Using student manual page 6. Ask the children to look for tiny snails elsewhere in the aquarium. After the children realize what snail eggs become, ask them to draw a cluster of snail eggs in the student manual. One child's record of young guppies and snails is shown in Figure 5-2.

"Inventing" the concept *birth*. Write the term on the chalkboard and tell the children that *birth* is the process by which new organisms come into being.

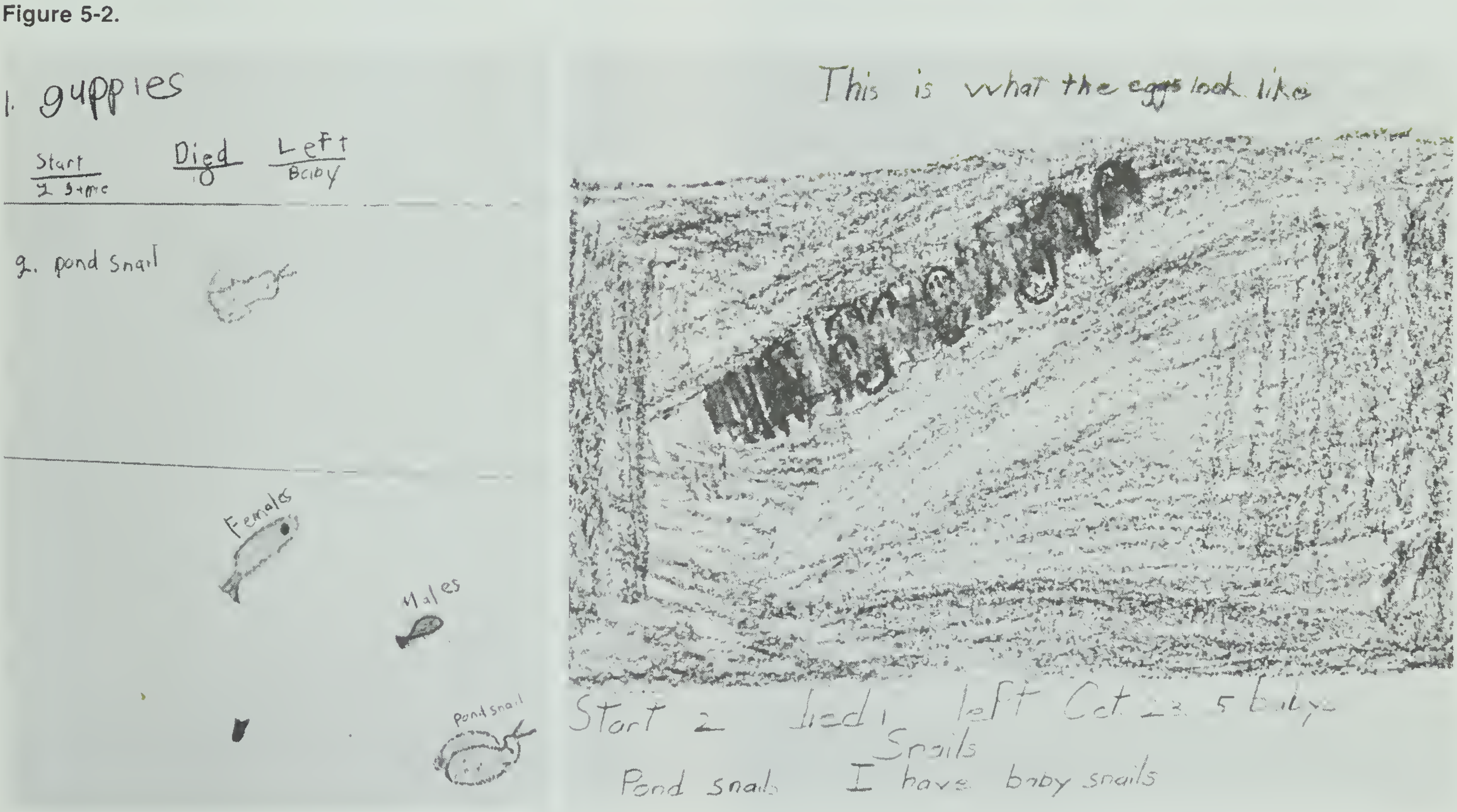
The term is technically limited to reproduction in organisms that have living young—other organisms are produced by fission, hatch from eggs, or germinate from seeds. For children at this level, the term is used broadly to encompass all methods of reproduction.



OPTIONAL ACTIVITIES

Do the parent guppies take care of the young? Have the children watch them to find out.

Figure 5-2.



Can the young guppies live without their mothers? Put some young in a separate container.

Where do the young guppies spend their time? Put five young guppies in a container with some plants. The children can draw "maps" of the young guppies' locations.

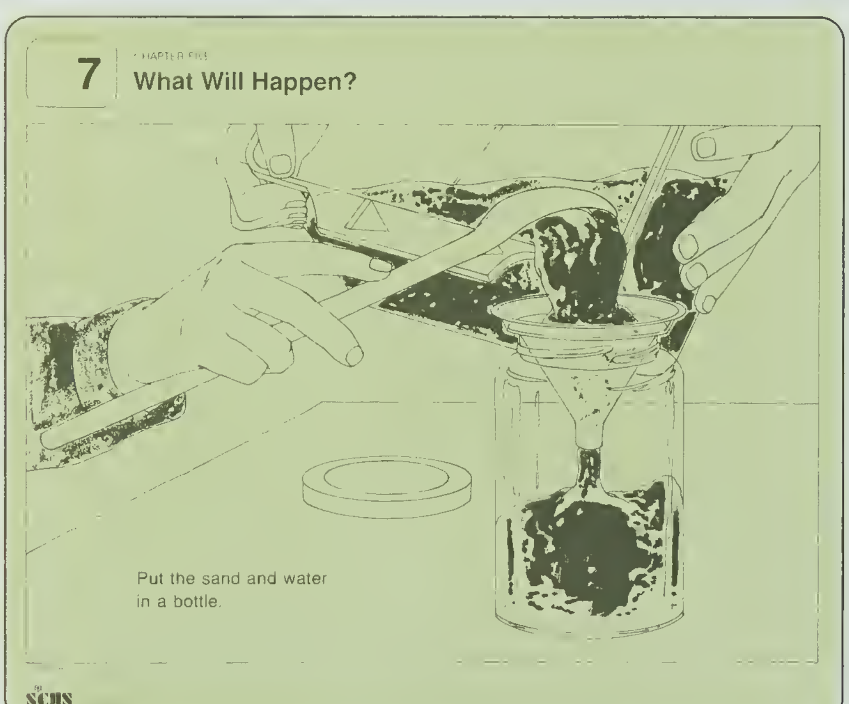
How many snail eggs are in a cluster? Circle several clusters for comparison.

Do adult snails pay attention to the eggs? Have the children observe the adults' locations and behavior.

Do snail eggs have to stay in water to hatch? Pour water from an aquarium until the circled eggs are exposed to the air. Have the children watch these eggs and compare them with eggs left in water.

EXTENDING YOUR EXPERIENCE CARDS

7. What Will Happen? The card user is to obtain a half-gallon glass container with a screw cap that can be fastened tightly. Some sand and decaying matter from the bottoms of the old aquariums are put in the container, and the container is almost filled with aquarium water. The cap is screwed on tightly. The child should observe the container for about a month to see whether new organisms appear.



6 Death in an Aquarium

SYNOPSIS

When a dead organism is discovered in an aquarium, it is kept for study so that the children can observe its gradual breakdown.

This prepares them for the recycling of materials seen in Part Six.

You invent the concept death.

Suggested time: *a few minutes at a time over several weeks*

TEACHING MATERIALS

For each child:

student manual page 7

For the class:

1 jar and cover*
dead organism

* provided by the teacher

TEACHING SUGGESTIONS

An exploration activity—observing changes in a dead organism—leads to invention of the concept *death*. This activity can be done only after an organism dies. If necessary, go on to Part Three and return at the appropriate time.

Observations. If several organisms die in one aquarium, remove and discard all dead bodies but one. Decomposition of more than one body could change the conditions in the aquarium, making it impossible for the other plants and animals to survive. The decomposition of one guppy or one snail probably will not seriously endanger the other living organisms and will give the children an opportunity to observe what happens after an organism dies. However, you may wish instead to put the animal and some aquarium water in a covered jar for study.

Figure 6-1. As a fish decomposes, the gases produced may lift it to the water surface.

Figure 6-2. Decomposition beginning.

Using student manual page 7. Whether the dead organism is a guppy, snail, or plant, have the children write its name in the manual. The dead animal will eventually disintegrate, but the specific changes accompanying the process cannot be predicted. Ask the children to observe the day-to-day changes that occur and picture them in the manual. Possibilities are:

- The water may turn cloudy and white as bacteria and protozoa feeding on the organism multiply.
- Green algae may appear, first around the dead body and then throughout the aquarium. The decaying organic matter acts as a fertilizer, promoting growth of algae.
- A fuzzy white mold may appear on a dead fish.
- A white scum may appear on the surface of the water.
- A dead fish may float.
- There may be an unpleasant odor.
- As the organism is broken down, the soft parts may disappear into the water.

As changes occur, ask the children what happens to the dead organism. Do the broken-down parts of the body remain in the aquarium? Let the children discuss what might happen to the parts.

Decomposition of plants. The children may also study the decay of aquarium plants. Though the

Chapter 6 7

What died in your aquarium?

Draw a picture.

Does the organism change?

What does it look like now?

Draw a picture.

moment of death is certainly less obvious in plants than in animals, decomposition is clear. The plant turns brown, pieces break off, and parts disappear.

"Inventing" the concept *death.* Write the term on the chalkboard and tell the children that death is the end of an individual organism's life.

Cleanup. A simple method of disposing of dead organisms is to wrap them in paper toweling and place them in a garbage can.

Extending Your Experience cards 1–7 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of the events in classroom aquariums, turn to page 68 of the evaluation section at the back of the guide.

Part Three

Habitats

OBJECTIVES

To use the term *habitat* to refer to a place where an organism lives.

To describe habitats found in the school area.

BACKGROUND INFORMATION

The central theme of the SCIIS life science program is ecology, or the study of interrelationships among organisms and their environments. The term *environment* refers to everything affecting the life of an organism—including other organisms, the earth, the sun, water, air. More and more, it includes things built by humans—buildings, parking lots, boats, planes, and so on.

On land, there are varied environments—hot or cold deserts, the temperate zones, hot humid tropics, and frozen polar regions. Farms, towns, and cities are environments for human beings and the plants and animals that live with us.

The seas, oceans, and shore areas are environments for many organisms, ranging from microscopic plants and animals to enormous sharks and whales.

Freshwater streams, ponds, puddles, reservoirs, and lakes are environments for freshwater animals—insects, crustaceans, snails, frogs, fish—as well as plants such as algae and water lilies.

Any organism's particular part of the environment is its habitat—the place where it lives. A cow, for example, might be found anywhere in a temperate terrestrial environment. But a certain cow's habitat might be limited to a farm in Michigan.

OVERVIEW

In this unit, children have experiences that lead to an understanding of the habitat concept: they plant seeds, cultivate plants, and set up and observe aquarium ecosystems. In Chapter 7, "Observing Organisms and Where They Live," the experiences continue during a field trip, as the children observe organisms in their habitats near the school. Chapter 8, " 'Inventing' the Concept Habitat," is based on these experiences with habitats. Discovery experiences follow the introduction of the term.

GETTING READY

Choose the site for the Chapter 7 field trip and make any preparations required in your school, such as sending notes to parents.

Prepare for Chapter 14 as follows.

- Combine the children into teams of two.
- For each child, fill a planter cup with soil.
- Distribute the cups
- Give each team a sprig of a real aquatic plant and one plastic plant.
- Have one child bury the real plant, the other child the plastic plant
- Then have them label each cup with the contents, the date, and their names.
- Encourage them to water the soil heavily, then set the planters aside. The planters should be watered once or twice a week thereafter.

7 Observing Organisms and Where They Live

SYNOPSIS

The class takes a field trip to search for organisms and to learn where they live.

Suggested time: *one class period*

TEACHING MATERIALS

For each child:

student manual page 8

ADVANCE PREPARATION

Survey the area around and near the school to find a suitable spot for a class field trip. You may use a park, a vacant lot, or simply trees and other plants at the edge of the playground.

Keep the field trip territory small, so that children will spend their time observing organisms rather than running about. If yours is a city school, one side of a street one block long might be needed. But if your school is in the country or near a park, use a smaller area.

In preparing the children for the trip, tell them to look for two kinds of information: first, they are to find as many different kinds of plants and animals as possible; second, they are to observe where each organism is found. Emphasize that they are not to collect the organisms but to leave the area as they found it. Also, they should replace any rocks or other objects they may move during their search.

Figure 7-1. Even this area provides many habitats.

Figure 7-2. Some animals may be found near tree roots.

TEACHING SUGGESTIONS

In this exploration lesson, children are prepared for later invention of the concept *habitat.*

Outdoor work. Exact identification of organisms by name is not important. When a child comes upon an organism none of you can name, simply give it a descriptive name such as "little blue flower," or "big brown bug."

Describing the characteristics of habitats is also more helpful than naming the habitats. Ask questions such as,

- Do some plants live in the open, where they get lots of sunlight?
- Do some animals live in shady areas?
- Do any plants live on streets, sidewalks, or paths?

Plants are easily found, but animals may be more difficult to locate. Tell your pupils to look for them on the ground, under rocks, around the base or trunk of a tree, and on leaves and branches or bushes. Also, you will probably have to tell the children that insects are animals.

Using student manual page 8. Return to the classroom before the children lose interest in the search. They may then report on the different plants and animals they found and describe where they found them. Each organism and its location should be listed in the manual. The children may also draw pictures or write stories about their experiences in their manuals.

8 Chapter 7

Where did you go?

What plants did you find?	Where were they?

What animals did you find?	Where were they?

Draw a picture or write a story.

MY FIELD TRIP

OPTIONAL ACTIVITIES

Can we make a new habitat? Place half an apple or potato on a bare patch of soil. Two or three days later, look for organisms there.

Is dead grass a habitat? Find some cut grass or weeds and pile them 6 inches deep on the ground. Two or three days later, bring all the grass and weeds into the classroom and then search through them for animals.

Where would you find a . . . ? Draw pictures of where you would expect to find fish, cows, worms, birds, frogs, or any other familiar animals. Do different places have different plants and animals living there? Let the children look at pictures of animals and plants living in their natural settings, settings such as forests and deserts.

8 "Inventing" the Concept *Habitat*

SYNOPSIS

Children's experiences with classroom plants and aquariums serve as the basis for the invention of the concept habitat.

Habitats are discovered in the children's recollections of past experiences, in books, and under the habitat board.

Suggested time: *several weeks*

TEACHING MATERIALS

For each child:

student manual page 9

For the class:

6 aquariums (prepared in Chapter 3)
4 cups sand‡
1 habitat board*

Drawer 4

1 six-liter container
1 dip net (coarse mesh)

* provided by the teacher
‡ in Sand and Soil box

ADVANCE PREPARATION

Prepare 6 liters of aged tap water and rinse 4 cups of sand. You should have set out a habitat board two or three weeks ago (see page 14).

TEACHING SUGGESTIONS

Chapters 2, 3, and 7 provided exploration experiences leading to invention of the concept *habitat*. You introduce the concept in this chapter, and the children are given an opportunity to discover more habitats outside the classroom.

Invention. Standing in front of the class, set up the aquarium by pouring the rinsed sand and aged tap water into an empty container. After the sand has settled, tell the children that a *habitat* is the place where a plant or animal lives. The aquarium is one kind of habitat.

Write the word *habitat* on the chalkboard.

- Ask the children what plants and animals in the room could live in the new aquarium habitat.
- Transfer a sample of each organism they suggest to the new container.
- After the transfer has been completed, ask the children to describe the new habitat.
- Then ask them why they did not suggest adding pumpkin plants, peas, or any other plants that are growing in the room.
- Accept all answers. The habitat concept will become more meaningful as the children discover other habitats on their own.
- Ask the children if they can think of any outdoor habitats that are like the aquarium.
- They may suggest ditches, ponds, lakes, and streams. If they do not, you should mention them.
- Remind the children of one or two plants or animals they observed on the field trip. Were their habitats different from the aquarium? In what way?
- Ask the children to name other organisms that have habitats different from or similar to the aquarium.

Cleanup. Return the organisms to the class aquariums.

Discovery. Take the class to visit the habitat board.

- Lift the board and let the children observe the organisms beneath it.
- The kinds of organisms living in the relatively dark, damp habitat beneath the board will depend on the locality and time of year.
- Ask the children to describe the conditions under the board (dark, damp, cool).

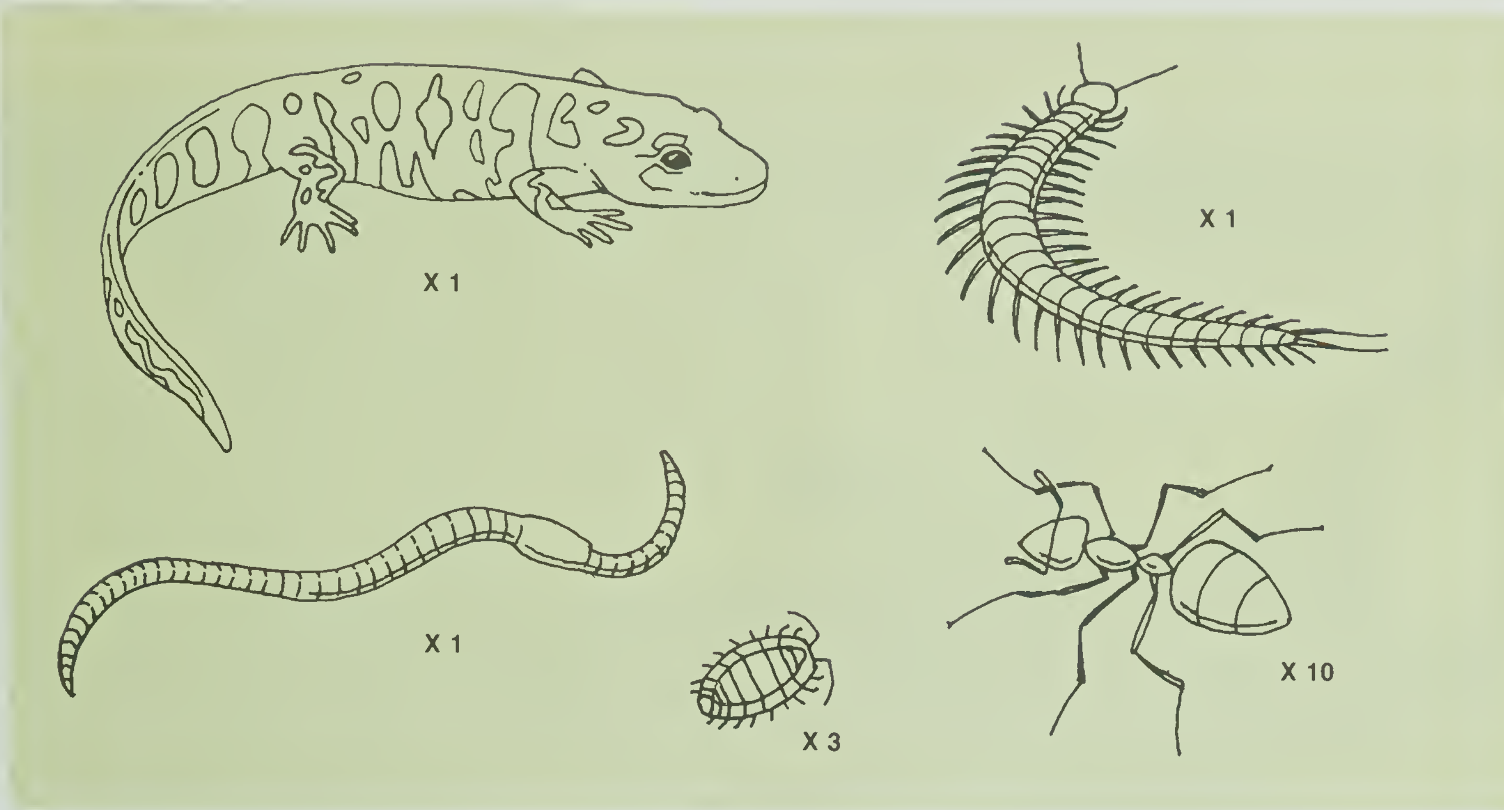


Figure 8-1. Some organisms that might be found under a habitat board *(clockwise from upper left)*: salamander, centipede, ant, isopod, earthworm.

- Ask them if they can think of other places where they might find the same kinds of organisms.
- Replace the board. Return every few days until the children's interest slackens.

Using the student manual page 9. Have children list or draw the organisms in the space under the habitat board picture.

Ask the children to name other habitats and suggest they look for some on the way to and from school. After the children have mentioned various habitats, use some of the following activities.

OPTIONAL ACTIVITIES

What do habitats look like? Children can draw pictures of plants and animals in their habitats. As an alternative, the whole class might draw a mural showing various habitats.

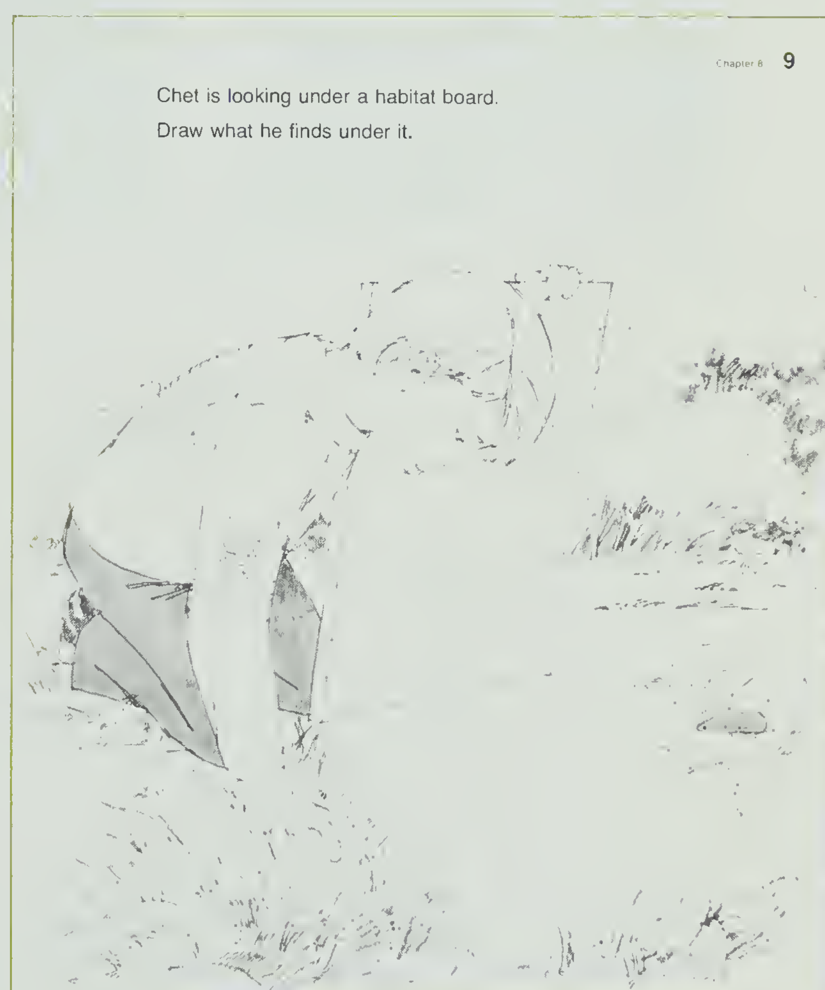
Have the girls and boys look through books and magazines for pictures of habitats. If appropriate, the pictures may be cut out and displayed on the bulletin board.

Read stories or show films about organisms and their habitats or ask the children to write stories about them.

Tell the children to bring in some vacation snapshots showing various habitats and to name the organisms that live there.

Can organisms live outside their habitats? Visit a zoo and ask the children whether they think the cages or other enclosures are like the animals' native habitats or different from them.

Take your class to a greenhouse. Ask students why the plants are grown under panes of glass rather than outdoors.


Chapter 8 9

Chet is looking under a habitat board.
Draw what he finds under it.

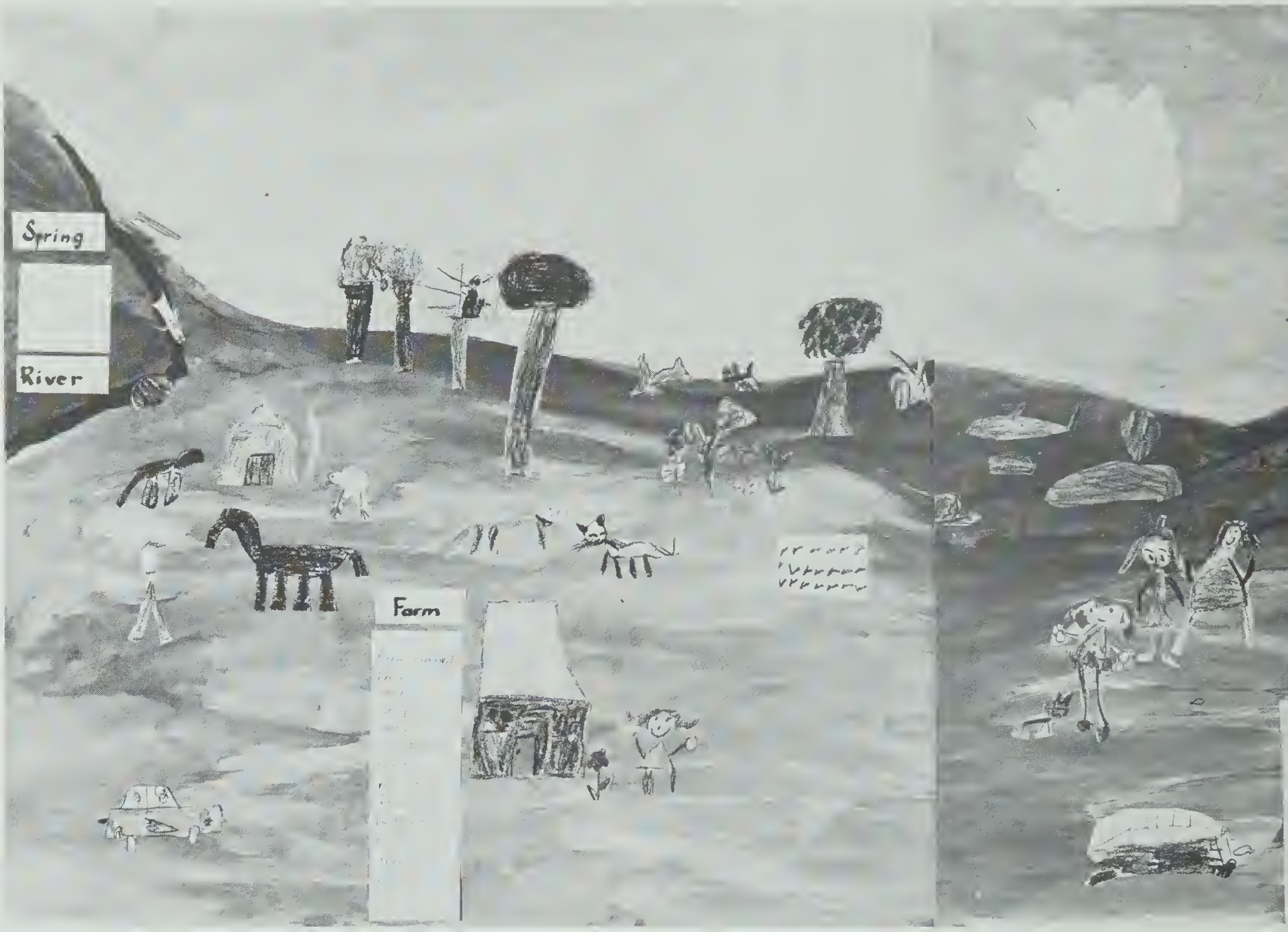


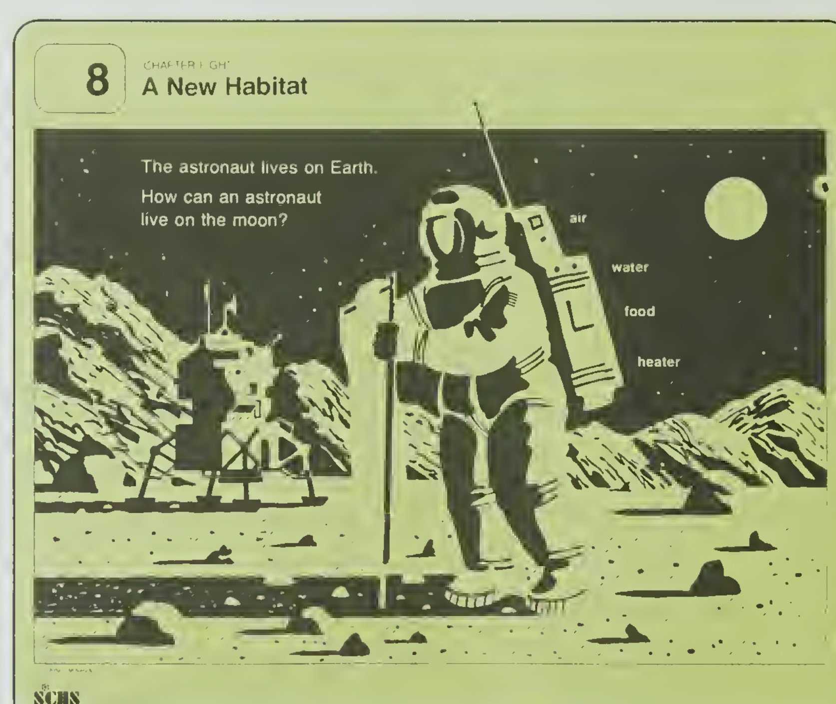
Figure 8-2. One class's mural of different habitats.

EXTENDING YOUR EXPERIENCE CARDS

8. A New Habitat. Have the child explain how equipment enables an astronaut to live temporarily away from Earth.

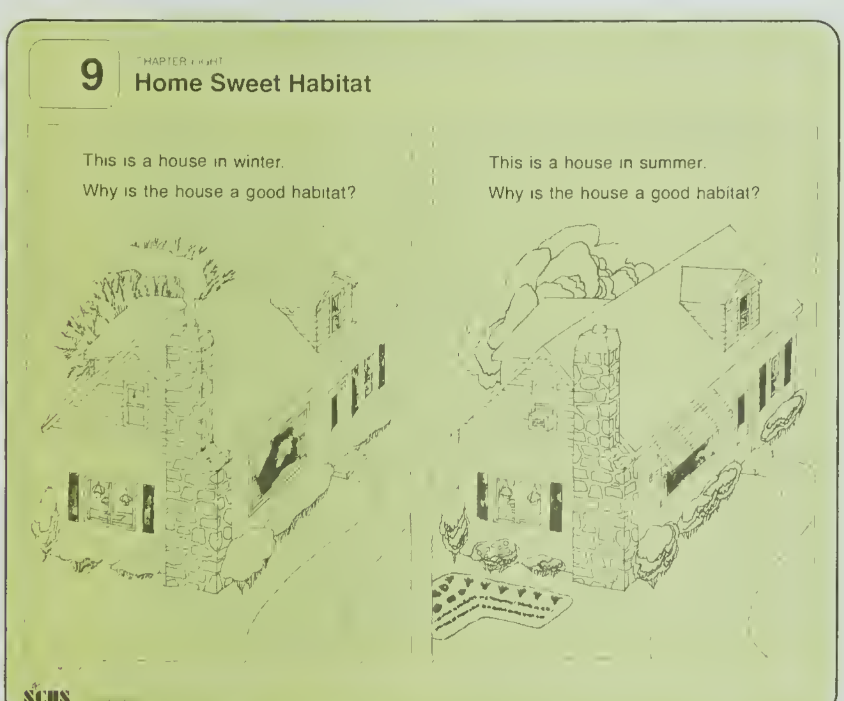
9. Home Sweet Habitat. Ask the child to explain why a house or apartment is a good habitat for humans in winter or in summer.

Extending Your Experience cards 1–9 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.



CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of the concept of habitats, turn to page 69 of the evaluation section at the back of the guide.


9 Home Sweet Habitat

This is a house in winter.
Why is the house a good habitat?

This is a house in summer.
Why is the house a good habitat?

SCHS

Part Four

Algae

OBJECTIVES

To make hypotheses about the reason for aquariums turning green.

To devise and carry out experiments to test hypotheses.

BACKGROUND INFORMATION

Algae are like most plants in that they use light energy to carry on photosynthesis, that is, to make food from water, carbon dioxide, and minerals. Unlike more familiar plants, algae have no roots, stems, leaves, or flowers. But they do not lack variety. While most are green, many algae are brown, gold, red, or blue-green. In fresh water, algae may be seen attached to rocks or floating as dense mats. Along ocean shores, the large brown kelps fastened to rocks are algae. And on land, some algae are green films on fence posts, tree bark, and mud.

Many algae are very small, and individuals can be seen only with a microscope. When microscopic green algae are present in large numbers, the water in ponds or aquariums appears green. It is likely that the fish, snails, and plants you placed in the aquariums already had algae on them. However, to make sure that the aquarium water became green, you were asked (page 17) to add a culture of algae.

OVERVIEW

It may take some time—a week to a month—for the water in the aquariums to become green. To hasten this process, be sure that some aquariums are in the light. When the water turns green, the children or you may ask why. The children test their hypothesis about the origin of green water in Chapter 9, "What Made the Water Green?" In Chapter 10, "Filtering Green Water," they filter the algae out of the water.

GETTING READY

When the water in the aquariums becomes green, order Live Organisms shipment O-2. Allow at least three weeks for delivery.

Figure IV-1.

9 What Made the Water Green?

SYNOPSIS

The children notice the green water and suggest causes for it.
Under your direction, they design and carry out experiments to test their ideas.

Suggested time: *about two weeks*

TEACHING MATERIALS

For each child:

student manual page 10

For the class:

1 bag soil‡

Drawer 2

2 planter bases
3 water sprinklers

Drawer 3

2 planter cups
ryegrass seed
1 roll labels

Drawer 4

1 dip net (coarse mesh)
5–10 tumblers

Drawer 5

several fluted containers

‡ in Sand and Soil box

ADVANCE PREPARATION

Prepare several liters of aged tap water.

TEACHING SUGGESTIONS

An unexpected event provides the stimulus for an exploration activity.

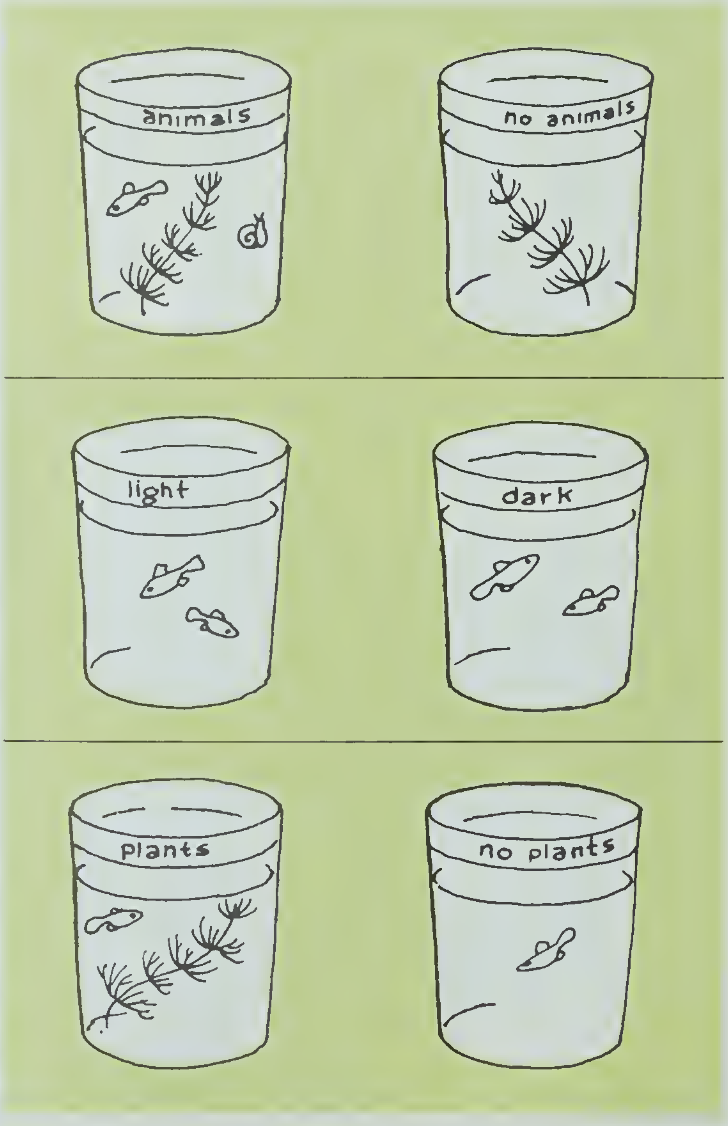
Observing a color change. When the children notice the green water, ask if they have any ideas about why it turned green. They may respond as follows:

"Plants melt in the sun."
"Fish eat plants and spit them out."
"Dead snails make it green."
"Maybe water just turns green."

Record all the children's ideas and use them to suggest an experiment.

Setting up the experiment. Each experiment should consist of two aquarium setups that differ in only one way, as in Figure 9-1.

Figure 9-1. Be sure that each experimental setup includes a control for comparison.



- If a child suggests that the plants in the aquariums (hornwort and sagittaria) cause the water to become green, prepare two containers—one with hornwort and sagittaria and one without.
- Place both containers side by side and wait. It doesn't matter what other things are in the aquariums—sand, fish, or snails—so long as they are in both aquariums.
- If some children suggest that fish cause the green water, again prepare two containers—one with fish and one without.
- A few children may notice that the aquariums near the windows or near a light source turned green, while aquariums in darker places in the room did not. They may suggest that light is the cause.
- To test this, move one of the nongreen aquariums into a lighter area and leave another nongreen aquarium in the darker place.
- Ask the children to watch the two aquariums for a week or more and to compare them.
- Do not expect the children's experiments to produce reliable answers. The important point is that the children have the experience of making hypotheses and observing experiments to test their ideas.

Using student manual page 10. Have the children draw pictures of the experiments. When the water turns green in an aquarium, they can color their drawings green with a crayon.

Discuss the results of each experiment:
- Ask why each experiment required two aquariums. Ask how the aquariums differed.
- If the children do not recognize the need for comparing two setups—one with the suggested cause and one without it—terminate the discussion. More experience may be needed before they can understand the need for an experimental control.

10 Chapter 9

Why do you think the water turned green?

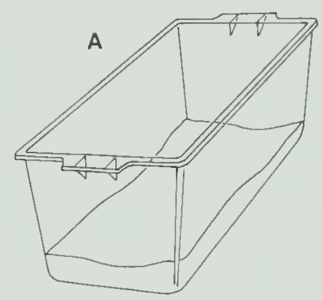
____

____

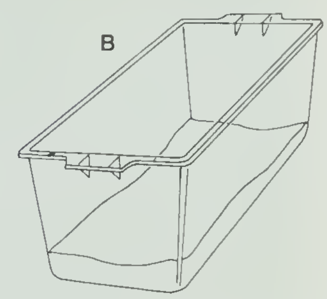
____

Draw a picture of how you found out.

A



B



What did you put in this aquarium? ______________

What did you put in this aquarium? ______________

Did one aquarium turn green? ________ Which one? ________

Color it green.

OPTIONAL ACTIVITIES

What will happen to the green water in the dark? Before placing an aquarium in a dark cupboard or closet, pour some of the green water into a tumbler and keep it in the light. A week later, compare a tumbler of water from the aquarium with the tumbler kept in the light. If there are fish in the aquarium, feed them daily.

Do land plants in soil become greener in light than in darkness? Sprinkle some ryegrass seed on soil in two planter cups. Water both; place one under the light source and the other in a dark cupboard. Compare the plants after the seeds have sprouted. Will the yellow plants grown in darkness become green in the light? Put some of the yellow plants under the light source, leaving the others in darkness. Compare them a few days later.

Cleanup. When the experiments have been completed and the results discussed, return the contents of the experimental containers to the original aquariums. Do not discard any green water. It will be used in later activities.

10 Filtering Green Water

SYNOPSIS

The children find that the green color is filtered out when water is poured through cotton. You identify the "green stuff" as algae, and the children use the cotton (containing algae) to turn colorless water green.

Suggested time: *several weeks*

TEACHING MATERIALS

For each child:

student manual page 11

For each team of two children:

Drawer 3

2 labels

Drawer 4

2 tumblers
2 plastic bags with twistems

Drawer 5

1 medicine dropper
1 funnel
1 cotton ball

For the class:

1 prepared aquarium containing green water
1 prepared aquarium containing clear water
1 cafeteria tray*

Drawer 2

1 light source

Drawer 4

1 tumbler

Drawer 5

1 funnel
1 cotton ball
1 baster

* provided by the teacher

ADVANCE PREPARATION

Half fill sixteen tumblers with green water.

TEACHING SUGGESTIONS

Following up the exploration activity in Chapter 9, you introduce the concept of algae growing in water.

Filtering sand. Tell the children they are going to do an experiment to find out more about what makes aquarium water green. Then, while the children are watching, set up a filtering apparatus as follows:

- Place a plastic funnel in an empty tumbler, narrow neck down.
- Dip a cotton ball in clear water and push it down tightly into the neck of the funnel.
- Using a baster, draw some sand and water from the bottom of a clear aquarium. Point out that both sand and water are in the baster.
- Then empty the baster into the funnel, pumping continuously.
- The water will pass through the cotton ball, but the sand will remain on the cotton. (If you find that the sand stays in the baster, scoop up the sand and water with a tumbler instead.)
- Tell the children that the water passed through the tiny holes in the cotton but the sand did not because the sand particles were too big.

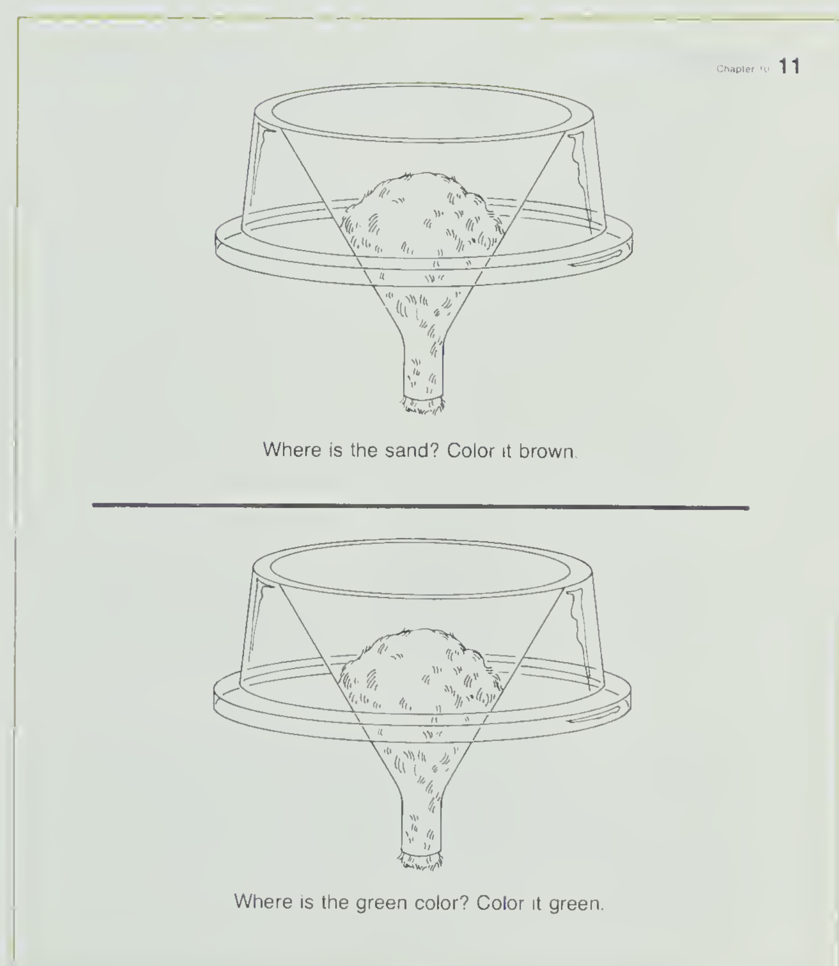
Figure 10-1. The cotton ball must be packed tightly through the small end of the funnel, so that all the water must pass through the cotton, not around it.

Figure 10-2. Transferring sand with a baster.

Using student manual page 11. Have the children use brown crayons to indicate sand.

Filtering green water. Tell the children that they will pour green water through cotton to see if they can separate the green color from the water. (This part of the activity may take several hours. You may want the children to set it up in the morning and add liquid throughout the day.)

- Divide the class into teams of two students.
- Give each team a cotton ball, a funnel, an empty tumbler, a tumbler half filled with green water, and a medicine dropper.
- Each team should place their funnel, neck down, in the empty tumbler.
- Tell the children to soak the cotton ball in clear tap water and press it tightly into the neck of the funnel (Figure 10-1). Help the children do this.
- Have each team use their medicine dropper to squirt half of the green water into the funnel.
- The cotton should turn green.
- Have the children pour the filtered water through the cotton a second time.
- Now ask the children to compare the filtered water with the unfiltered green water. How do they differ?
- What happened to the green stuff that was in the water before it passed through the cotton?


Chapter 10 11

Where is the sand? Color it brown.

Where is the green color? Color it green.

Figure 10-3. Filtering green water.

Using student manual page 11. Have each child show the location of the green color with a green crayon.

Invention. Remind the children that sand could not pass through the cotton because the sand particles were too big.

- Was the green stuff also made up of particles too big to pass through the cotton?
- No matter how the children respond, tell them that the green material in the water and on the cotton balls is made up of many tiny green plants. Each plant is too small to be seen by itself (except with a microscope), but if there are many of the plants in the water, the water appears green.
- Tell the children these plants are called *algae*. Write the word on the chalkboard.
- If you think looking at algae through a microscope will help convince the children that the green stuff is made up of tiny plants, borrow a microscope and set up a demonstration as directed in Extending Your Experience card 10, "Looking at Algae."

Feedback experiment. Now tell the children that you added a small number of algae to each aquarium on the day the children built them and that these algae increased in number until the aquarium water became green.

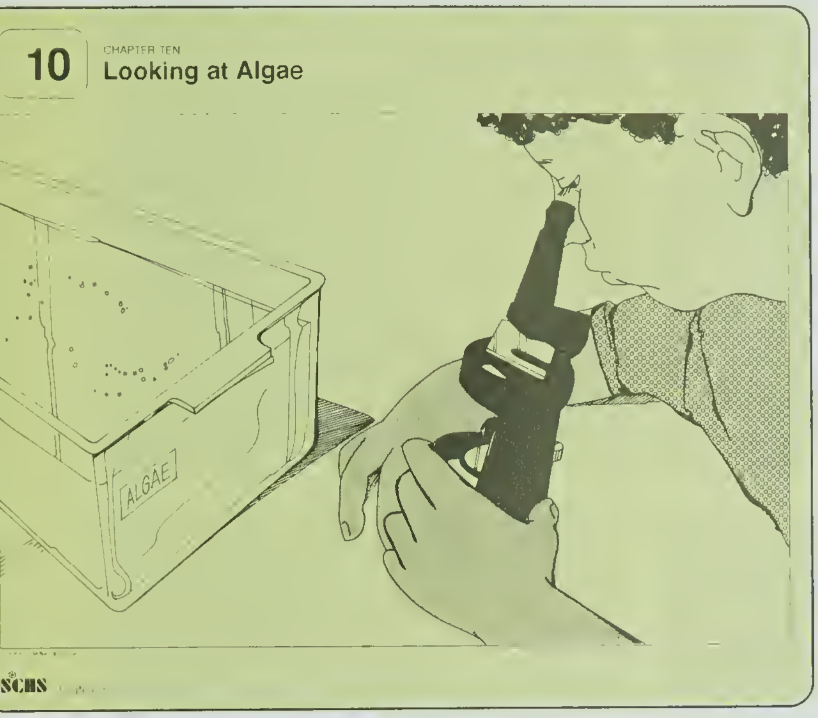
- Ask what would happen to a tumbler of clear water if the green cotton was dropped into it and the water was allowed to stand for several weeks.
- If the children understand that the algae you added to the aquariums caused the water to become green, they should predict that the clear water in the tumbler also will become green.
- Let the teams test this prediction; the children should empty and rinse the tumblers containing filtered water, add clear aged tap water, and then drop in the green-stained cotton.
- Collect the tumblers on a tray and place them under the light source or near a window.

Algae hunt. Ask the children if they have seen green stuff that might be algae outside the classroom.

- No matter how they respond, tell them to look for algae on the way to school and at home.
- Give a plastic bag to each of the children and ask them to place in the bags anything they think might be algae. Tell them to look in wet or damp places, such as ditches or puddles, and to bring the samples to school.
- In the classroom, have the children fill the bags with water and close them with twistems.
- Tell them to write their names and where they found the samples on labels and to stick the labels on the bags.
- After observing the samples for a week or so, they should report observations and decide whether each sample is algae or not.
- Ask for reasons with each response.

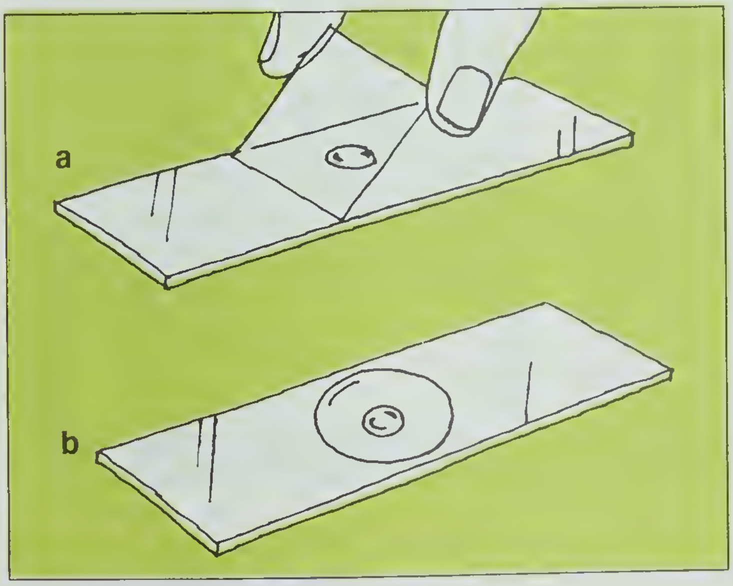
EXTENDING YOUR EXPERIENCE CARDS

10. Looking at Algae. Put a drop of "green water" in the well of a depression slide or put it on a plain slide and add a cover slip. If you are familiar with using a microscope, set it up for the children and do the focusing yourself. If you have children's microscopes available, you can let the children explore without danger of breaking the slide.



Extending Your Experience cards 1–10 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

Figure 10-4. Before examining a drop of liquid, *(a)* lower one edge of the cover slip onto the slide, then release it. Or *(b)* use a depression slide, which requires no cover slip.



Part Five

Food Chains

OBJECTIVES

To determine what various aquarium organisms eat and what each is eaten by.

To use the term *food chain* for the feeding relationship among organisms.

To diagram a food chain.

BACKGROUND INFORMATION

Plants and animals in any given area live together because they obtain certain requirements of life from each other. One of the major requirements is food. A green plant manufactures its own food by combining energy from sunlight, water and minerals from the soil, and carbon dioxide from the air. This process is called photosynthesis. Some of this food is used by the plant as it grows. Excess food is stored in the plant's tissues.

Animals cannot make their own food. Instead they must obtain food by eating other organisms. Some animals eat plants, making use of plant tissues and stored plant food for their own growth and development. Other animals eat the plant-eaters and obtain (secondhand so to speak) the energy and materials originally contained in the food produced by plants.

By identifying the eaten and the eaters in a series, we can build up a food chain. One example is:

grass → cattle → humans.

Grass plants make their own food. When the grass is eaten by cattle, some of the food and plant tissue produced by the grass plants is transformed into the flesh of the cattle, which in turn becomes food for humans. The arrows indicate the direction the food moves through the chain.

A food chain that you can demonstrate in the classroom involves algae, daphnias, and guppies.

Daphnias are small, freshwater animals related to larger animals such as crabs, crayfish, and lobsters. A daphnia can be seen with the naked eye (it is about 3 mm, or ⅛ in, long), but the structure of the animal can best be observed with a magnifier. An enlarged view is shown in Figure V-1.

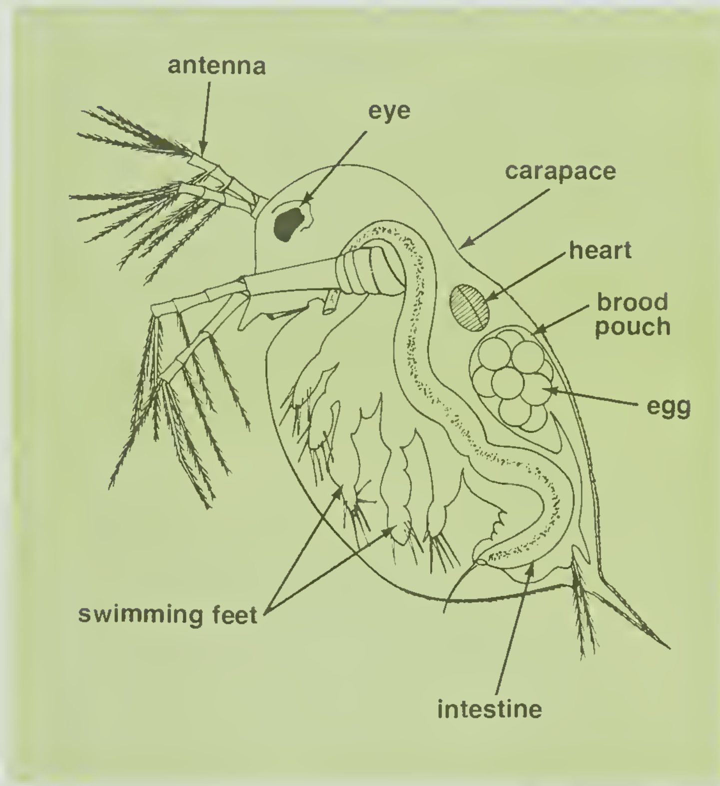


Figure V-1. A daphnia, magnified about 50 times. The antennae are used for swimming. Each daphnia has only a single, black eye. The carapace is transparent, and so the intestine shows through. Being filled with algae, the intestine is usually green.

OVERVIEW

In Chapter 11, "Daphnias," the children observe daphnias, paying special attention to the intestinal contents and to what the organisms eat. In Chapter 12, "Guppies Eat Daphnias," daphnias are added to an aquarium containing hungry guppies. The children observe the guppies capture the daphnias. The relationship of eaters and eaten is diagramed on the chalkboard as:

algae → daphnias → guppies.

You invent the term *food chain* and ask the children to suggest food chains from their own experience.

GETTING READY

A week before beginning Chapter 12, put six guppies in aged tap water. Do not feed them for a week.

11 Daphnias

SYNOPSIS

Children observe several daphnias in a vial containing algae.
They observe individual daphnias, describe what they have seen, and draw pictures of the animals on the chalkboard.

Suggested time: *about two weeks*

TEACHING MATERIALS

For each child:

student manual page 12

For each team of two children:

Drawer 3

1 label

Drawer 4

1 magnifier
1 tumbler

Drawer 5

1 plastic vial

For the class:

1 Algae aquarium, prepared in Chapter 3
3 jars of daphnias†
1 cafeteria tray*
drawing paper*

Drawer 4

1 dip net (fine mesh)
1 tumbler

Drawer 5

1 baster
1 medicine dropper

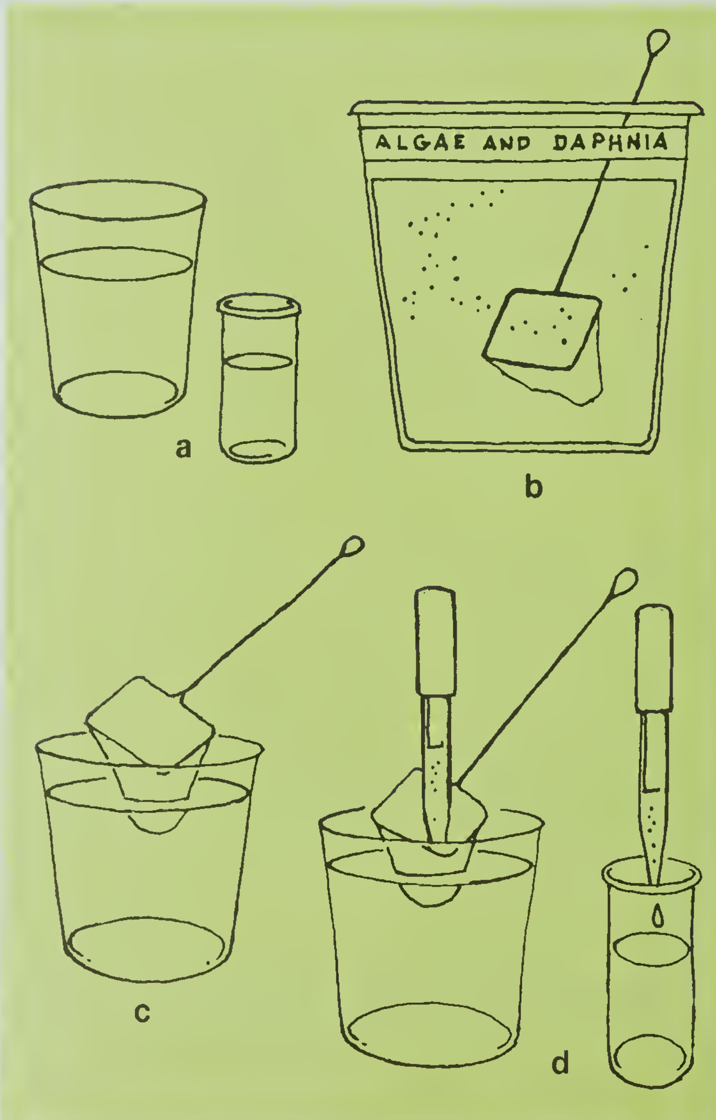
* provided by the teacher
† in Live Organisms Shipment O-2

ADVANCE PREPARATION

Prepare a stock culture of daphnias as follows:

- Pour the contents of the shipping container through a fine-mesh dip net and discard the water.
- Transfer the animals in the dip net to the Algae aquarium (prepared in Chapter 3).
- Add "and Daphnias" to the aquarium label.
- Prepare 4 or 5 liters of aged tap water.
- Prepare one vial containing three or four daphnias for each team of two children, using the technique shown in Figure 11-1. (If you have difficulty using the medicine dropper, try using the baster instead. Children usually cannot control the baster well enough, but adults can.)

Figure 11-1. *(a)* Half-fill a tumbler with aged water, and fill a vial with green aquarium water. *(b)* Using the fine dip net, scoop some daphnias from the Algae and Daphnias aquarium. *(c)* Lower the dip net into the tumbler until the daphnias are in the water. *(d)* Use a medicine dropper to transfer the daphnias to the vial.



TEACHING SUGGESTIONS

An exploration activity with daphnias begins a series of observations leading to the invention of *food chain*. As this activity continues the children's work with algae, it also provides the discovery phase of another learning cycle.

Observing daphnias. Give a vial of daphnias and a magnifier to each team.

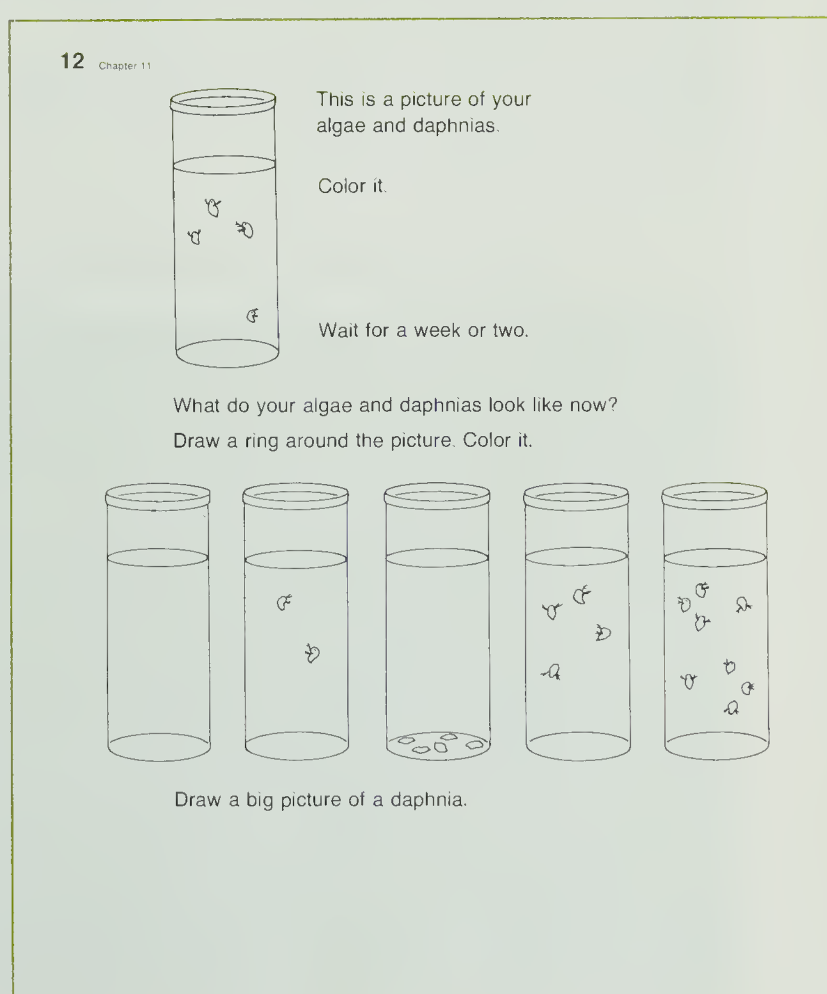
- Tell the children that these little animals live in the same ponds and lakes as algae.
- Ask the children to count the number of daphnias, record the number and their team symbol on a label, and fasten the label to the vial.
- Let the children observe the daphnias for several minutes.
- Then ask them to place the vials on a tray near a source of light but not in direct sunlight or in other hot areas.

Changes in daphnias. During the next week or two, let the children observe the vials each day, adding a little aquarium water as necessary to compensate for evaporation. Several events may occur during this time:

- The daphnias may die.
- The daphnias may produce young and increase in numbers.
- If the daphnias increase in number, ask the children whether some are smaller than others. Then ask them where the smaller organisms may have come from.
- If no one mentions birth, remind them of their earlier experience with the birth of baby guppies or snails. Do not carry the discussion of birth beyond the fact that it was the cause of the increase in numbers.
- If the daphnias disappear, ask the children what might have happened. Whatever their answers, suggest that they look at the material on the bottom of the vial, where they may observe shells.
- The water may become clear because the daphnias ate most of the algae or because the algae settled to the bottom. To see if the latter is the case, tell the children to shake the vials gently.
- If the water appears clear even after a vial is shaken, ask the children what might have happened to the algae. If no one suggests that the daphnias ate the algae, you mention this possibility.

Using student manual page 12. Have each child circle and color the picture that shows the result in the team's vial.

Figure 11-2. Empty daphnia shells (carapaces).


12 Chapter 11

This is a picture of your algae and daphnias.

Color it.

Wait for a week or two.

What do your algae and daphnias look like now?

Draw a ring around the picture. Color it.

Draw a big picture of a daphnia.

Observing individual daphnias. Give each team an empty tumbler and tell the students to turn it upside down on a piece of white paper, creating the shallow observation dish shown in Figure 11-3.

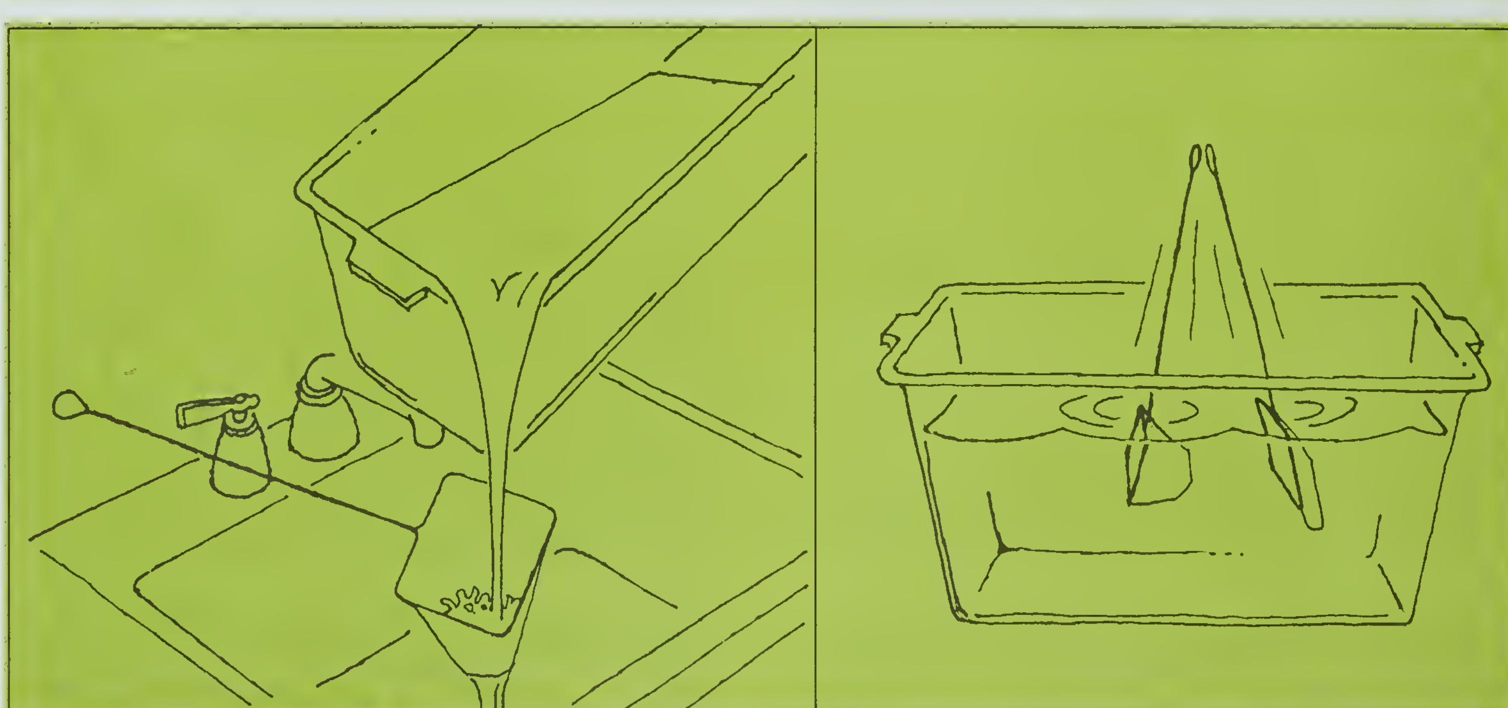
- Using a medicine dropper, remove two or three large daphnias and a drop of water from a vial and put the organisms on the inverted tumbler.
- If you need more animals, collect them from the Algae and Daphnias aquarium.
- Ask the children to observe the organisms with their magnifiers.
- If the animals' intestines are green, be sure that your pupils notice it. Point out the elimination of feces (the remains of digested food), also.
- Ask what food would make a daphnia's intestine green. If no one mentions algae, you should do so.
- Let the children report what they have seen. Ask children to draw pictures of daphnias on the chalkboard.
- Disagreements will probably arise. Use these to suggest that the children look at the daphnias more closely.
- Do not expect the children to draw exact replicas of daphnias.

Using student manual page 12. After the children have reached some agreement about what daphnias look like, have them draw one in their manuals.

Cleanup. Return any daphnias remaining in vials and tumblers to the Algae and Daphnias aquarium. Wash and store the vials and tumblers.

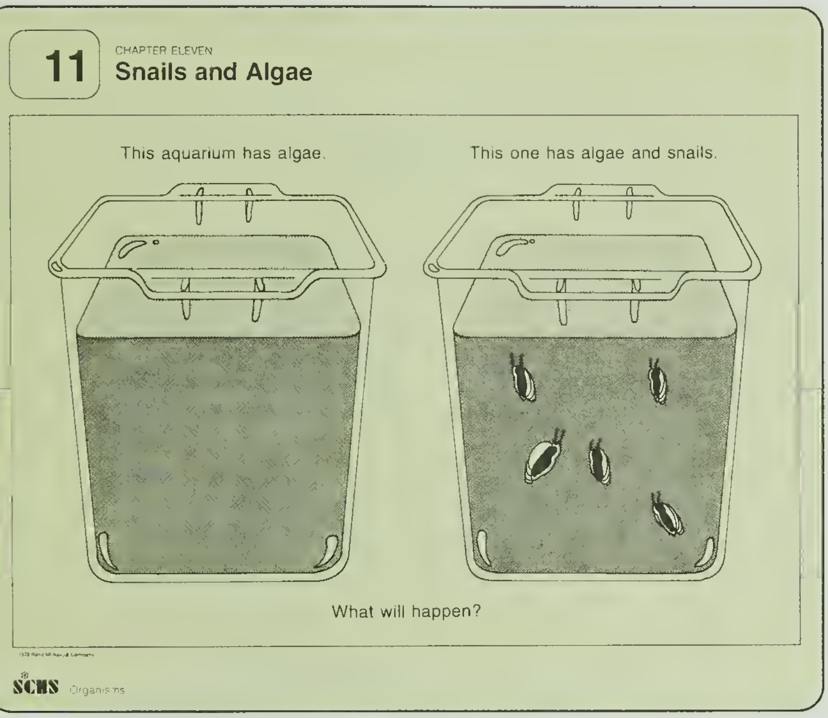
Figure 11-3. Observing daphnias in an "observation dish."

Figure 11-4. To return the daphnias to their original aquarium, pour them into a fine dip net. Then lower the net into the aquarium and swish it back and forth.

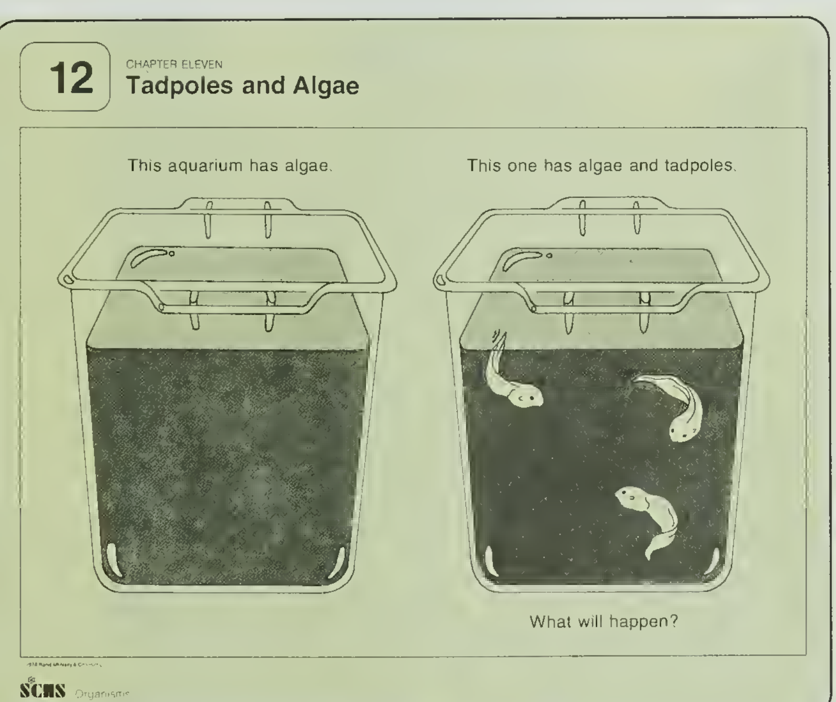


EXTENDING YOUR EXPERIENCE CARDS

11. Snails and Algae. Help the child set up two green aquariums—one with snails and one without—and place them both in light to see if snails keep the aquarium walls free of algae.



12. Tadpoles and Algae. Have the boy or girl add some tadpoles to an aquarium containing algae.



12 Guppies Eat Daphnias

SYNOPSIS

You invent the term food chain *after the children watch guppies eating daphnias. You diagram the food chain*

algae → daphnias → guppy

for the children.

Suggested time: *two class periods*

TEACHING MATERIALS

For each child:

student manual pages 13 and 14

For the class:

1 Algae and Daphnias aquarium (prepared in Chapter 11)
6 guppies

Drawer 5

7 fluted containers
6 plastic vials

ADVANCE PREPARATION

On page 45, you were asked to place six guppies in a container of aged tap water and to give them no food during the week preceding work on this chapter. Now prepare six vials, each containing ten to twenty daphnias in aged tap water.

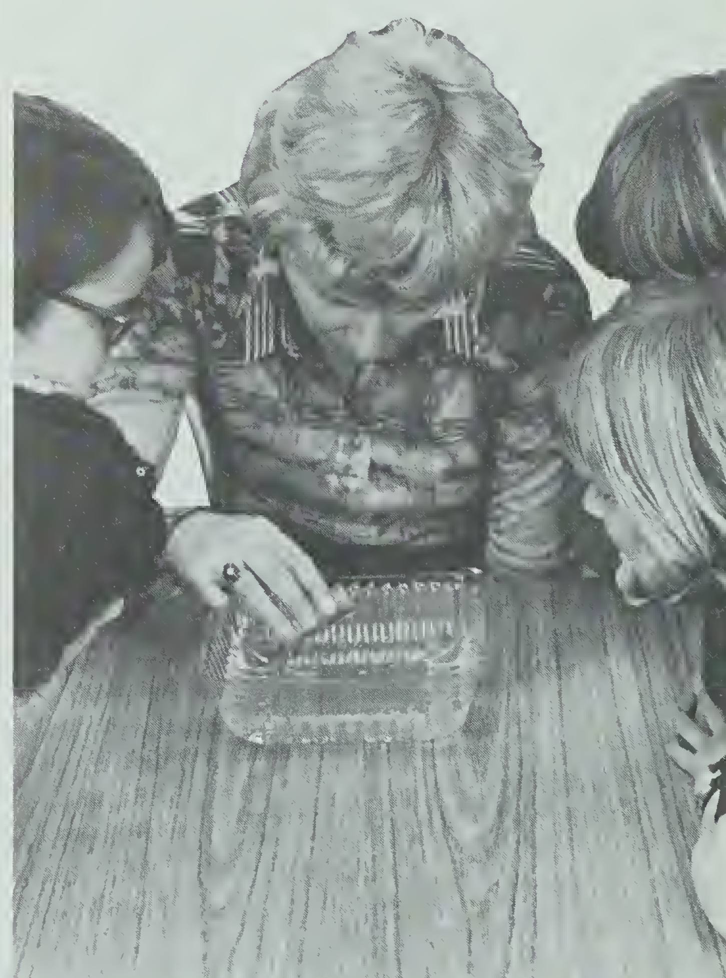
TEACHING SUGGESTIONS

Food chain is invented following more exploration, and food chains are found outside the classroom in a discovery activity.

Guppies eat daphnias. Add one hungry guppy to each of six containers and spread them around the room so that every child can get a good view of what happens. Ask the children to watch the guppies while you pour one vial of daphnias into each container.

Discussion. After the children have observed the guppies capture daphnias, ask them to report their observations. Ask, "What did the guppies do?" "What happened to the daphnias?" "Are they food for guppies?"

Figure 12-1. The daphnias will probably disappear rather quickly after you give them to a guppy.



Invention. Write on the board: Daphnias are food for guppies.

- Say that you will write it a shorter way. Write

  daphnias → guppies

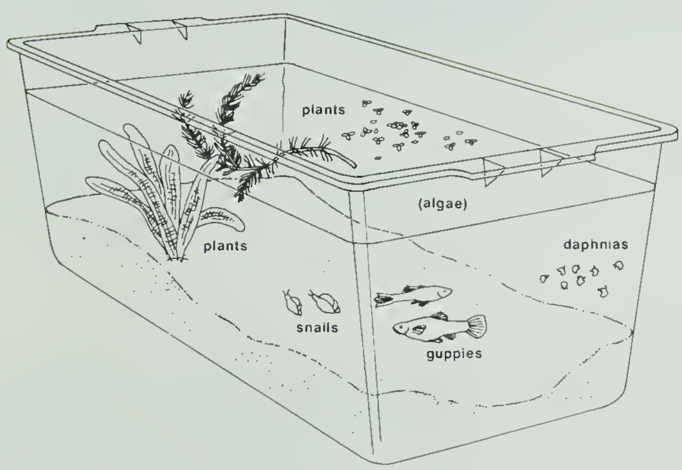
  on the chalkboard.
- Explain that the arrow means *are eaten by.*
- Ask the children what daphnias eat.
- If the children do not say "algae," you should.
- Then write:

  algae → daphnias → guppies.
- Tell the children that the diagram shows a *food chain.*

Using student manual page 13. Have the students add arrows to the aquarium drawing to make a food chain.

Chapter 12 13

Draw arrows to show a food chain.



Draw arrows to show food chains.

algae	daphnias	guppies
plants	snails	
algae	guppies	
grass	cows	humans
corn	humans	
corn	pigs	humans

Discovery. On the next day, write

algae → daphnias → guppies

on the chalkboard and ask the children what this is called.

- If they do not say "a food chain," tell them again.
- Then ask if they can suggest other food chains.
- If they have no suggestions, ask, "What do you eat?"
- If they mention a plant, write the name of the plant on the chalkboard, draw an arrow after it, and write *humans* after the arrow.
- If they mention food from animals, such as beef or pork, write *cow* or *pig* on the chalkboard followed by:

  → humans.
- Then ask what the cow or pig ate.. Write whatever they suggest to extend the food chain.

Using student manual pages 13 and 14. Have the children complete page 13 by drawing arrows showing food chains.

Ask the children to create food chains by drawing arrows from food animals to Bobbie, then from plants to the animals (including Bobbie) that eat them. Some food chain possibilities are:

corn → pig → Bobbie
grass → cow → Bobbie
tomato → Bobbie

14 Chapter 12

Bobbie is eating dinner.

What foods is she eating? ____________________

____

Draw arrows from food animals to Bobbie.

Draw arrows from plants to the animals that eat them.

What do the pictures and arrows show? ____________________

Cleanup. Return the guppies and daphnias to their original aquariums. Rinse and store the containers and vials.

OPTIONAL ACTIVITY

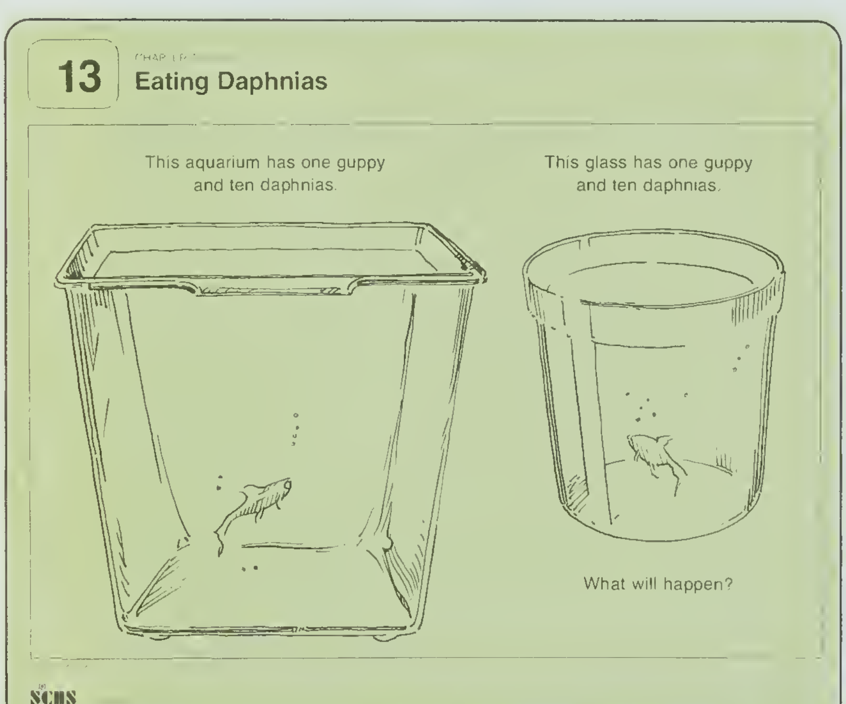
May I feed the guppies? Put a tumbler of daphnias and a medicine dropper beside one of the class

Figure 12-2.

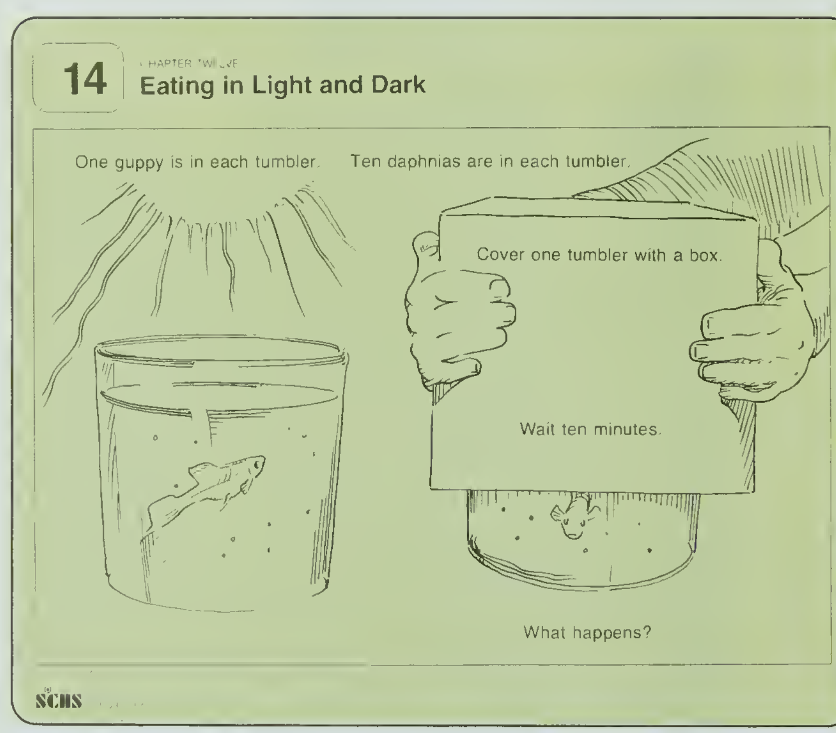
aquariums. The children can add the daphnias to the aquarium and watch the guppies eat.

EXTENDING YOUR EXPERIENCE CARDS

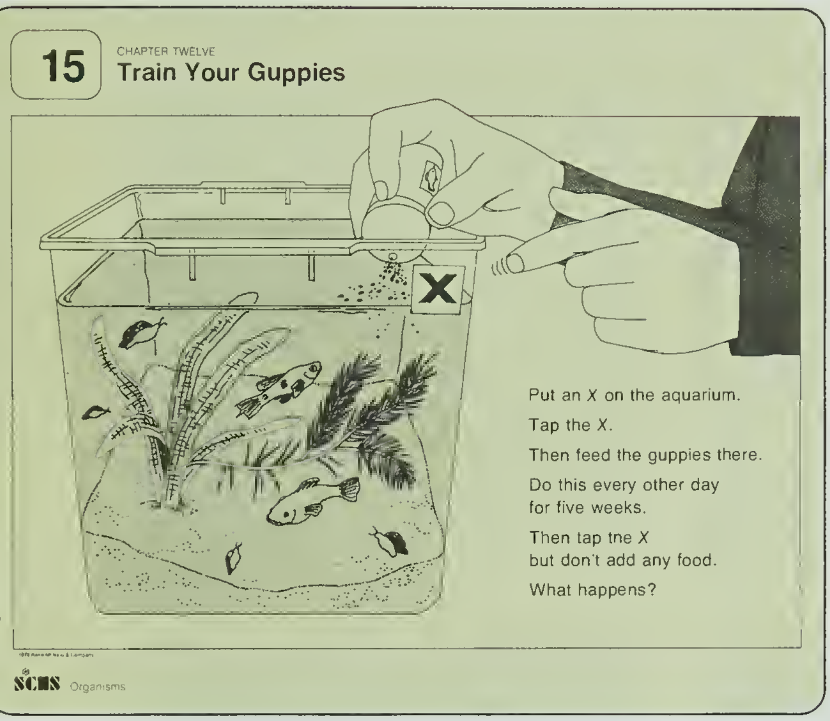
13. Eating Daphnias. The card user should put one hungry guppy in a large container and another in a small plastic tumbler, then add ten daphnias to each container and watch to see which guppy eats all ten first.



14. Eating in Light and Dark. The child is to place ten daphnias and one hungry guppy in each of two tumblers and immediately put a cover over one tumbler to exclude all light. After ten minutes, he or she removes the cover.



15. Train Your Guppies. The pupil marks a corner of the aquarium with an *X*. Every day thereafter, the child should tap the aquarium at *X* and immediately add fish food at the same corner. In about three to five weeks, the guppies should come to the corner in response to the tapping, even if no food is added.



Extending Your Experience cards 1–15 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of the concept of food chains, turn to page 70 of the evaluation section at the back of the guide.

Part Six

Decay

OBJECTIVES

To observe and describe the gradual collection of "black stuff"—detritus— in an aquarium.

To propose and test hypotheses about the source of detritus.

To use the term *decay* to describe the breakdown of organic material.

To describe the effect of detritus on plant growth.

BACKGROUND INFORMATION

Soil contains minerals essential for plant growth. Many of these come from the gradual disintegration of rock. However, this disintegration is extremely slow, and some soil minerals (such as nitrogen) are not found in rocks. For plants to have enough essential minerals for good growth, a secondary source of soil minerals is needed. This secondary source is decaying organic matter—dead bodies of plants and animals and wastes from animals.

Organic wastes and dead bodies of plants and animals are gradually decomposed by bacteria and molds in soil. Minerals in bodies of dead organisms and in organic wastes are released to the soil, where they can be absorbed and used by plants. In contrast, the organic compounds in plastics are largely resistant to the action of decomposers.

The gradual accumulation of black stuff on and in the aquarium sand consists of decomposing organic matter from dead animals and plants and waste materials from fish, snails, and daphnias. This decaying matter, called detritus, is similar to the organic matter that accumulates in the earth's soil.

OVERVIEW

In Part Six, the children notice (or you direct their attention to) the detritus in the aquariums. After you introduce the term *detritus* in Chapter 13, "What Is the 'Black Stuff'?" the children speculate on where it comes from and carry out experiments to test their ideas. They relate detritus to the decay of a buried plant in Chapter 14, " 'Inventing' Decay." Finally, with your guidance, they set up an experiment (Chapter 15, "Soil Fertility") to compare the growth of seedlings with and without detritus. Chapter 16, "Setting Up Aquariums at Home," provides an opportunity for you to distribute the organisms and for the children to set up home aquariums.

Figure VI-1. Detritus increases soil fertility.

13 What Is the "Black Stuff"?

SYNOPSIS

A newly prepared aquarium is compared with an old aquarium containing noticeable detritus*—a term that you invent.*

After comparing and observing the difference, the children suggest sources of the detritus*.*

The experiment to test their ideas.

Suggested time: ***several weeks***

TEACHING MATERIALS

For each child:

student manual page 15

For the class:

1 Algae and Daphnias aquarium
1 aquarium containing detritus
2 sprigs hornwort or dwarf sagittaria
4 or 5 guppies
4 or 5 snails
1 cafeteria tray*

Drawer 4

1 six-liter container
10–30 tumblers
magnifiers
1 dip net (coarse mesh)

Drawer 5

1 baster
medicine droppers

* provided by the teacher

ADVANCE PREPARATION

Prepare aged tap water and rinsed sand for the new aquarium.

TEACHING SUGGESTIONS

The children carry out an exploration activity, investigating the detritus in an aquarium.

Setting the stage. Using the sand and aged water you have prepared, set up a new aquarium. With the help of the children, transfer one or two plants from another aquarium and add several guppies and snails.

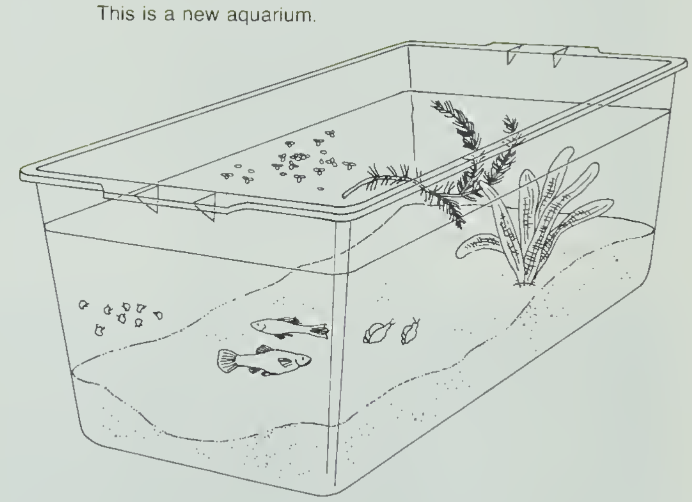
Select an old aquarium that has a distinctly visible accumulation of detritus and place it beside the new one.

What is it? Ask the children to compare the two aquariums and to describe any differences.

- If no one mentions the detritus, point to it and ask the children what they think it is and where it came from.
- After the children have run out of suggestions, tell them that it is called *detritus*.
- Let them look at other aquariums in the room and at the Algae and Daphnias aquarium. Do they all have detritus?

Chapter 13 15

This is a new aquarium.



Use a black crayon to change it to an old aquarium.

Where did the black stuff come from?

____

____

What is it called? ______________________________

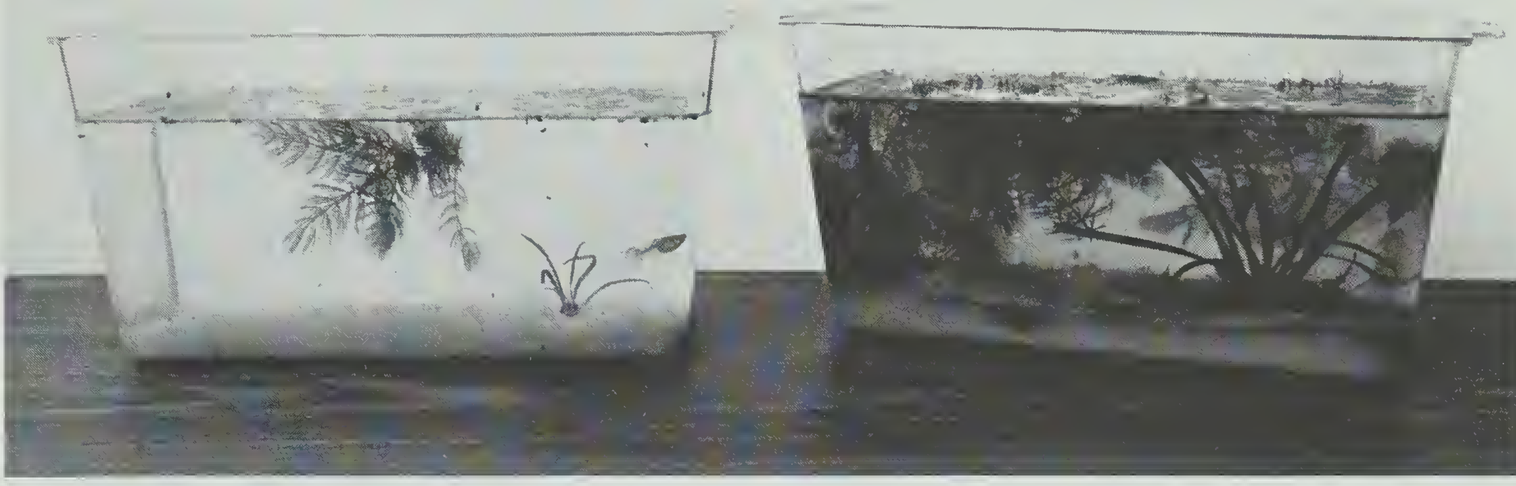


Figure 13-1. In an old aquarium, detritus will be seen on the sand surface.

Using student manual page 15. Tell the students to color the picture of the new aquarium "old," using a black crayon to add a dark layer to the sand.

Where does it come from? Ask the children whether detritus will appear in the new aquarium.

- Tell them to look at it daily to see if detritus appears and to see whether they can observe any events that might cause this.
- As soon as detritus begins to appear in the new aquarium, point it out.
- Ask if anyone can suggest now where the detritus could have come from.
- Let the children report their observations and suggest ideas about the source of detritus. They may suggest dead fish, plant leaves, and so on.
- Ask them where the eliminated feces might go.
- Ask if they have seen the guppies eliminating feces.

How can we find out? Suggest setting up some new aquariums to test the children's ideas about the origin of detritus. List the ideas (hypotheses) and divide the class into enough teams to test each idea.

Give each team a tumbler containing aged water. Each team can then set up its tumbler in the way the pupils think will cause detritus to accumulate. Possible setups are:

- fish and water
- snails and water
- daphnias and water
- plants and water
- sand and water

Tell the students that you are setting up a tumbler containing water only. Ask why this setup is necessary. If they cannot tell you, point out that every tumbler has water in it. This is the only way they can be sure detritus doesn't come from the water itself.

Set all the tumblers on a tray and put them aside. At weekly intervals, have the children observe the tumblers. Eventually they will see that detritus appears only where there are organisms.

Using student manual page 15. When the students have found some sources of detritus, tell them to list the sources in their manuals.

Further evidence. Remove some detritus from the Algae and Daphnias stock culture aquarium with a baster and place it on top of an inverted tumbler, as shown in Figure 13-2. Let the children observe it with magnifiers. Ask them to look for cast-off shells of daphnias.

Cleanup. Return the organisms to the class aquariums. Wash and store the tumblers.

Figure 13-2. Transferring detritus.

14 "Inventing" Decay

SYNOPSIS

The children examine real and plastic plants that were buried in moist soil for several weeks.
You invent the concept **decay**.

Suggested time: *one class period for advance preparation, another period for the activity*

TEACHING MATERIALS

For each child:

Drawer 2

1 planter base

Drawer 3

1 planter cup

For each team of two children:

1 dead or dying plant, 2–3 cm (1 in) long

Drawer 5

1 plastic plant

For the class:

Drawer 2

3 water sprinklers

ADVANCE PREPARATION

You should have prepared for this activity several weeks in advance, as directed on page 29.

TEACHING SUGGESTIONS

Exploration activities in this chapter and the previous one lead to your introduction of *decay*.

Observing results of decay. Distribute the planter cups, along with some newspapers or trays to work on, and tell the children to dig up their plants.

- Ask if everyone has found a buried plant.
- When half the children report that their planters are empty or that only part of the plant is there, ask if anyone can explain what happened.
- Children who have used the SCIIS unit *Material Objects* may recall that plastics and natural materials have unlike properties. In any case point out that each team buried one plastic plant and one real one.
- Now ask why the plastic plants are unchanged but the real plants have disappeared.
- Accept all answers, reasonable or fanciful.

"Inventing" *decay*. Explain that living plants and animals die, as the children saw with aquarium organisms. The materials in dead organisms and in waste materials break down; that is, they *decay* and go back to the earth. Plastic plants or animals may crack, but they do not die, and the materials in them are not completely broken down for a very long time.

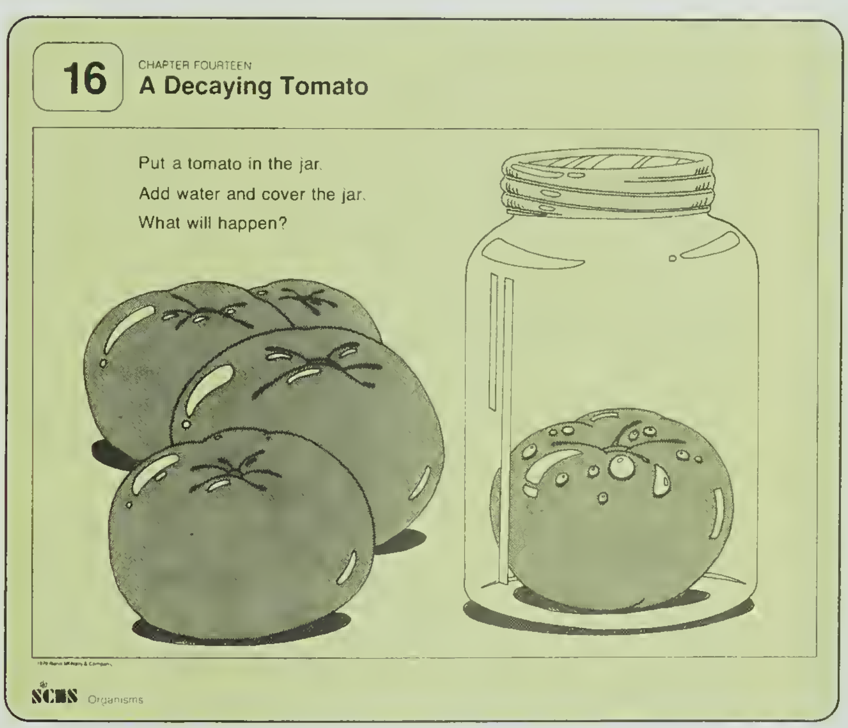
- Write the term *decay* on the chalkboard.
- Ask the children to suggest examples of decay. One suggestion, even if it must be yours, should be detritus.
- Ask which planter would be a better place to plant seeds—the one in which the plastic plant was buried or the other one, in which the real plant decayed.
- Take a vote. Then tell the children they can test their ideas in the next science class.

Cleanup. Wash the plastic plants and planter assemblies and return them to the kit.

EXTENDING YOUR EXPERIENCE CARDS

16. A Decaying Tomato. Children put a tomato in a jar, sprinkle the tomato with water, and cover the jar. Then they watch over several days or weeks as it decays. The precise changes that will occur cannot be predicted with certainty. Blackish or brownish spots, caused by bacterial rot, may appear on the fruit. Molds may grow on the surface. Eventually the tomato will disintegrate into a watery (probably smelly) mess.

Figure 14-1. The plastic plants will be intact, but the real plants will probably have decayed.



15 Soil Fertility

SYNOPSIS

The children set up an experiment to determine the effect of decayed material on plant growth: they compare seed growth in sand containing detritus with growth in sand only.

After seeing the results, they are asked to explain the differences.

Suggested time: *two or three weeks*

TEACHING MATERIALS

For each child:

student manual page 16

For the class:

aquariums containing detritus
2 sheets of green construction paper*
scissors*
paste*
1 stirring stick*
sand‡

Drawer 2

1 light source
1 water sprinkler

Drawer 3

80 mustard seeds

Drawer 4

3 tumblers
1 dip net (fine mesh)

Drawer 5

1 baster

* provided by the teacher
‡ in Sand and Soil box

ADVANCE PREPARATION

Wash enough sand to fill a couple of tumblers. Pour off and discard the water.

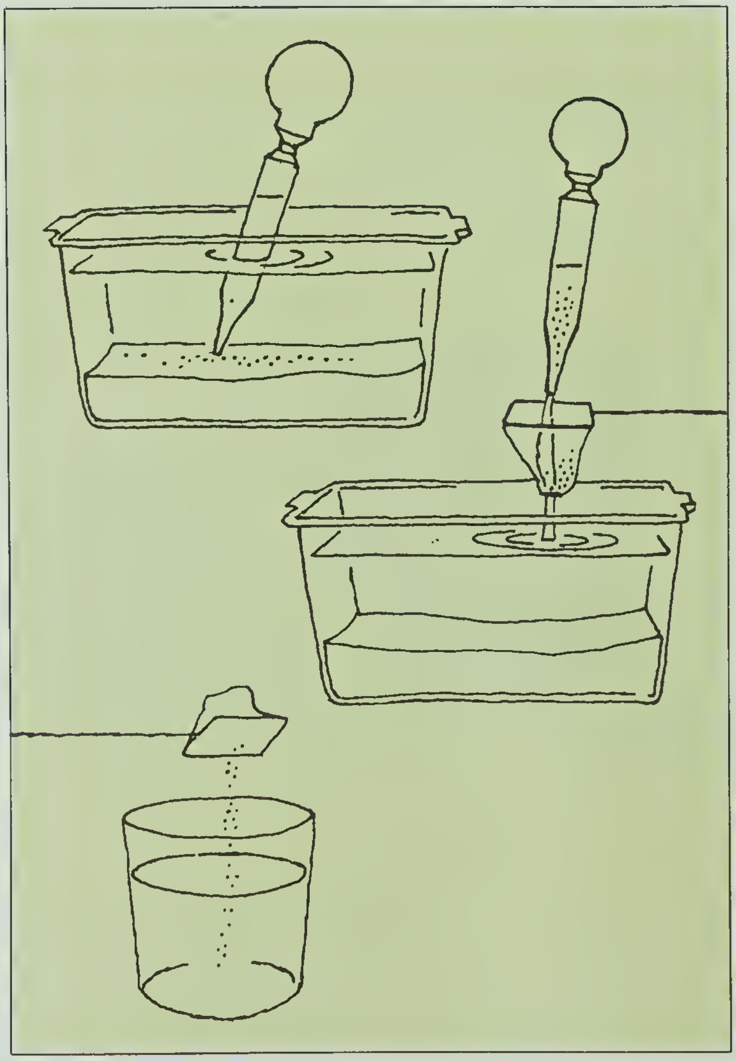
TEACHING SUGGESTIONS

The decay concept is strengthened through this discovery activity, showing decayed matter's fertilizing action.

Predicting results. Review the results of Chapter 14. Tell the children they will test the effects of decayed material on plant growth by using detritus from the aquariums.

Collecting detritus. With the help of the children and using the method shown in Figure 15-1, collect as much detritus as you can from the aquariums. Repeat until you have collected all available detritus. The sand you collect along with the detritus will not affect the result of the experiment but try not to dilute the detritus with too much sand.

Figure 15-1. Collect detritus from the bottom of an old aquarium with a baster, then empty it into a fine dip net. Empty the dip net into a tumbler.

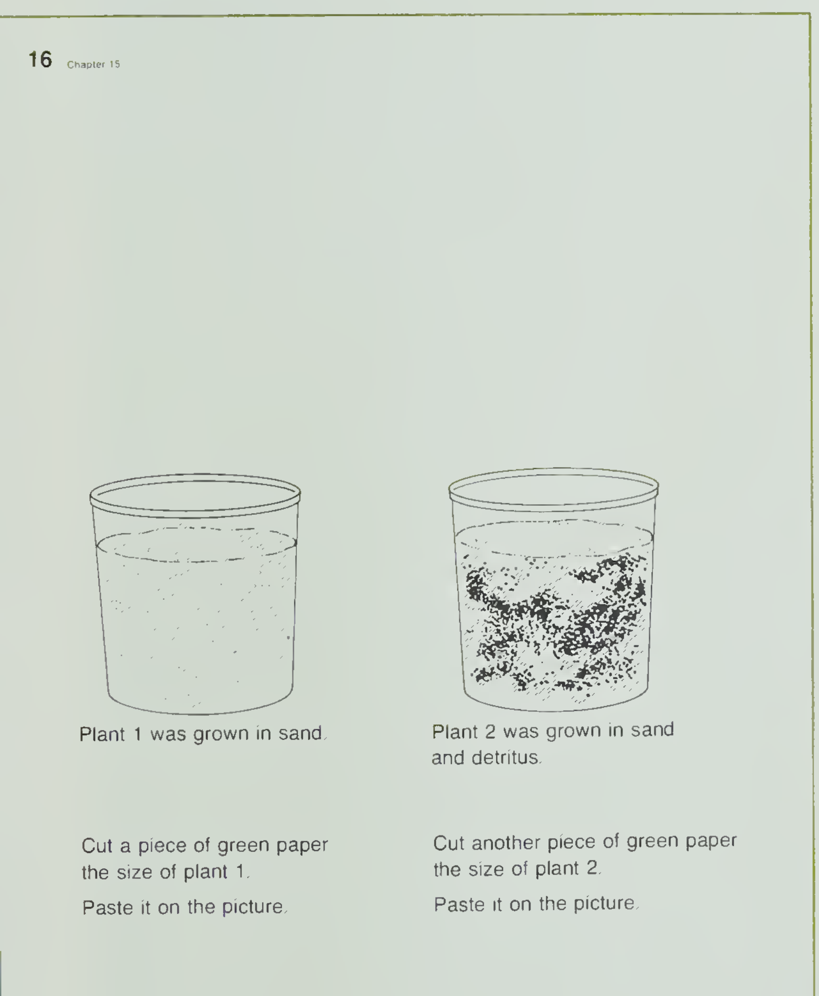


Preparing the sand. Half fill two tumblers with washed sand. Add the detritus collected from the aquariums to one of the tumblers. Mix the sand and detritus thoroughly. Add washed sand to the other tumbler to bring the level up to that of the mixture of sand and detritus.

Planting seeds. Plant about forty mustard seeds in each tumbler. Then water them and label the tumblers. Place the two tumblers where they will receive the same amounts of light and heat.

- Ask the children to predict what might happen to the plants that grow from the seeds.
- Will the plants be any different in the two tumblers or will they be just alike?

Using student manual page 16. Show the children the picture of the tumblers and tell them to color (with brown crayons) the part of the picture that shows sand mixed with detritus.


16 Chapter 15

Plant 1 was grown in sand.

Plant 2 was grown in sand and detritus.

Cut a piece of green paper the size of plant 1.

Paste it on the picture.

Cut another piece of green paper the size of plant 2.

Paste it on the picture.

Observing the results. Two or three weeks later, when there are obvious differences in the plants in the two tumblers, ask the children to compare the plants.

- Let the children examine the labels on the two tumblers to determine which contained detritus and which did not.
- Ask them to explain the difference in the seedlings in the two tumblers.

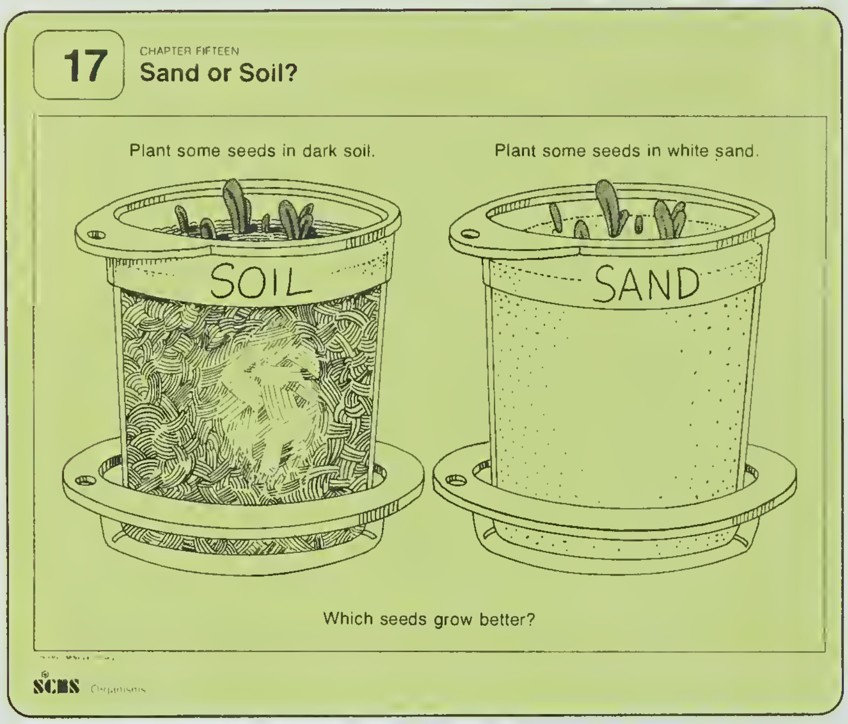
Using student manual page 16. Have each child cut two strips of green paper, one the average height of the plants in the tumbler containing detritus, the other the height of the control plants (Figure 15-2). Each "plant" should be pasted on the appropriate picture in the manual.

Cleanup. Throw away the sand, detritus, and plants. Wash and store the tumblers.

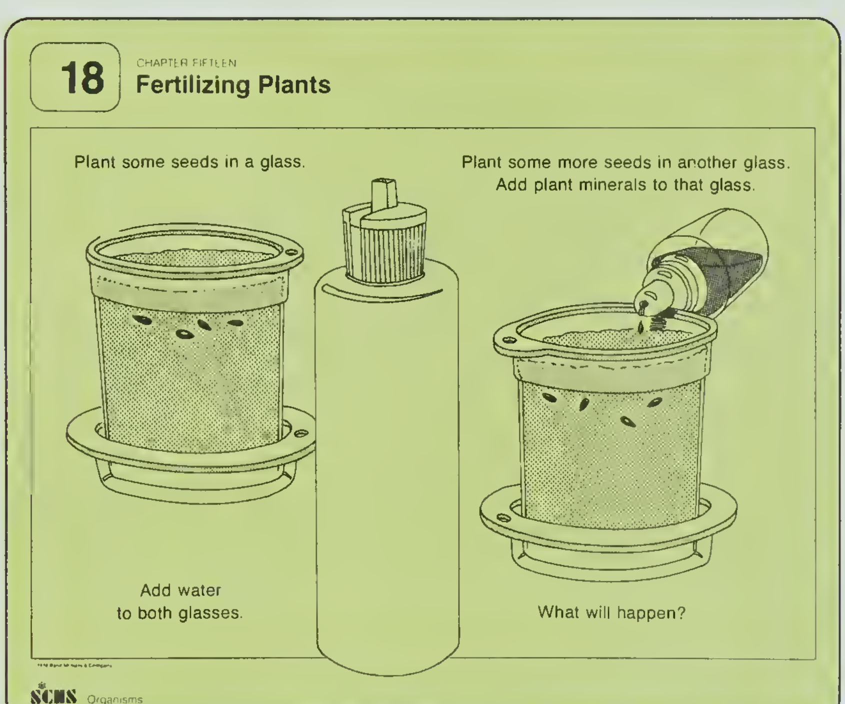
Figure 15-2. Each strip of green paper represents the average height of plants in one tumbler.

EXTENDING YOUR EXPERIENCE CARDS

17. Sand or Soil? To compare the growth of mustard seedlings in garden soil (or potting soil from a nursery) with growth in pure sand, a child can set up this experiment.



18. Fertilizing Plants. Tell the child to prepare two tumblers of washed sand and to add commercial fertilizer to one, mustard seeds to both.



16 Setting Up Aquariums at Home

SYNOPSIS

The contents of the classroom aquariums are distributed to the children to take home and care for.

Suggested time: *one class period*

TEACHING MATERIALS

For the class:

6 aquariums

Drawer 4

2 dip nets (fine mesh and coarse mesh)
32 plastic bags with twistems

Drawer 5

1 baster

ADVANCE PREPARATION

Prepare 6 liters (1½ gallons) of aged tap water.

TEACHING SUGGESTIONS

Here, the children review the unit and discover new applications of several concepts.

Distributing the organisms. Tell the children to ask their parents if they may take home the animals and plants from this unit so that they can set up their own aquariums.

If there are not enough organisms for each child to have one of each kind, have a lottery or devise some other method to distribute them as equally as possible.

Give each child a plastic bag and a twistem. Ask the children to squirt two basterfuls of aged tap water into each bag. Using the dip net, baster, or their hands, they can transfer the organisms from the aquariums into the plastic bags and close the bags with twistems (Figure 16-1).

Figure 16-1. This unit may begin a lifelong interest in aquarium organisms.

After the children have collected the organisms in their plastic bags, ask what they will do with them at home:

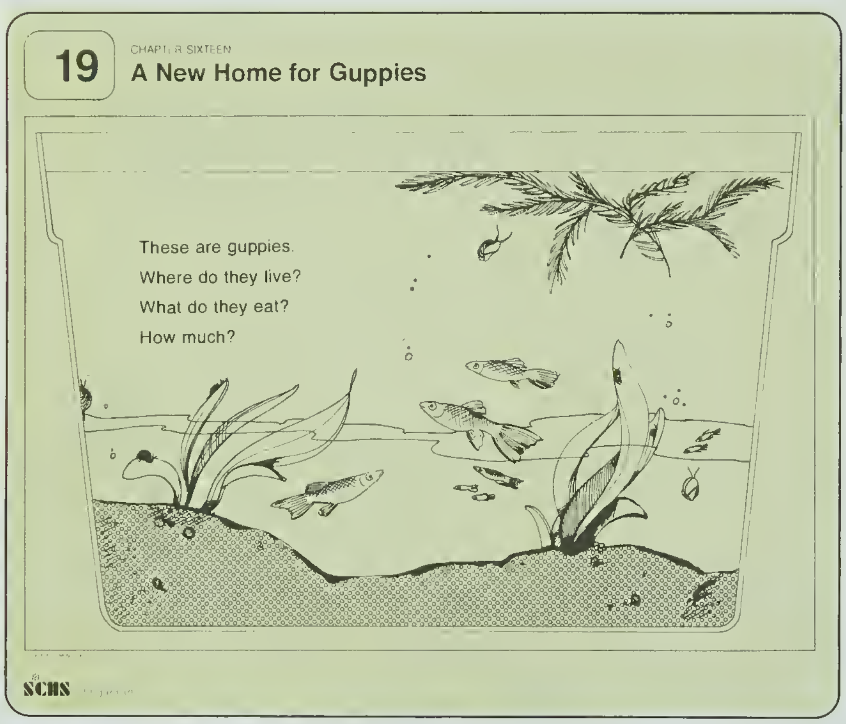
- What organisms are you taking home?
- What kind of container will you put them in?
- Where will you place the container? Why?
- What will you feed the organisms?
- What changes may occur in your aquarium? What may cause these changes?

The next day, ask the children what they did with their organisms when they got home.

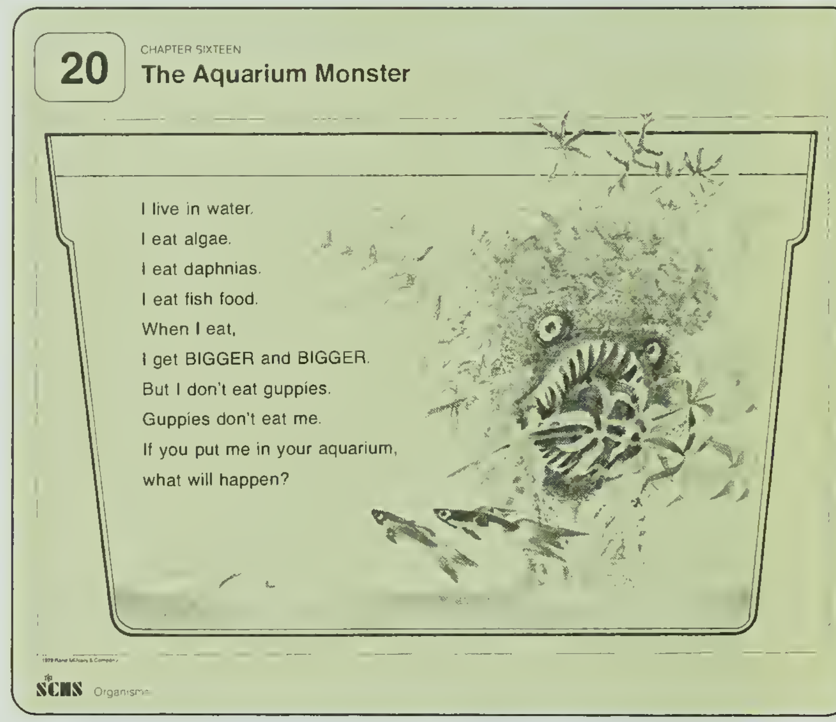
Cleanup. To wash the used sand, fill each aquarium with water. Stir up the sand, let it settle, and pour off the water. Repeat several times to wash away the detritus. Let the sand dry before storing it for future use.

EXTENDING YOUR EXPERIENCE CARDS

19. A New Home for Guppies. Use this card for talking with children who plan to take the guppies home. Be sure they understand that the fish are to be fed sparingly with daphnias or commercial fish food.



20. The Aquarium Monster. If the children have understood the interrelationships among the aquarium organisms, they will realize that the monster will not only take the guppies' food but will also grow so large it will crowd them.



Extending Your Experience cards 1–20 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's ability to plan and use experiments, turn to page 71 of the evaluation section at the back of the guide.

Appendices

Evaluating Your Students

SCIIS bears upon many aspects of each child's growth and learning, and evaluation may therefore take a variety of forms. We believe the most significant evaluation should occur informally, while the regular classroom activities are going on and you can observe each child's attitudes, skills, and performance, rather than in formal "test" situations. Test scores alone are not appropriate to describe attitudes, and they often are inadequate measures of children's skills or understanding of science concepts. For these reasons we have provided three kinds of evaluation activities:

A. CONCEPT/PROCESS EVALUATION
- **Activity 1. Identifying Requirements for Plant Growth**
- **Activity 2. Describing Events in Aquariums**
- **Activity 3. Identifying Organisms and Habitats**
- **Activity 4. Diagraming Food Chains**
- **Activity 5. Discussing Experiments**

B. ATTITUDES IN SCIENCE
- **Curiosity**
- **Inventiveness**
- **Critical Thinking**
- **Persistence**

C. PERCEPTION OF THE CLASSROOM ENVIRONMENT
- **Our Science Class**

An important feature of the evaluation materials is that they can help you identify problem areas and plan more effective teaching of subsequent parts of the unit. In concept/process evaluation, the "Follow-up" section at the end of each activity provides specific suggestions for remedying weaknesses in student understanding. The materials for assessing children's attitudes and their perception of the classroom environment contain suggestions that can help you improve your teaching effectiveness as well as the attitudes and performance of students. We hope you and your students find these activities both enjoyable and beneficial.

Concept / Process Evaluation

The activities in this section are designed to help you evaluate children's ability to identify and describe the major science concepts and processes of the unit. As explained in the unit "Overview" on page 1, these major concepts and processes are:

organism	**death**	**food chain**
birth	**habitat**	**decay**

In addition, certain secondary concepts and processes are introduced to help the children deal with their observations. These are: male, female, detritus.

Objectives indicating the concepts and processes emphasized are listed at the beginning of each Part in the Teacher's Guide. Children's understanding and mastery of most concepts and processes can be evaluated informally as the class works through regular activities. It is worthwhile to evaluate children more than once during the unit, because individuals will achieve desired levels of competence at different times.

All of the concept/process evaluation activities can be carried out with individuals or small groups. Thus, you can use an activity to evaluate just the children for whom you are lacking notes or observations. Some activities also lend themselves to use with the whole class; this is indicated where appropriate.

The activities in this section provide you with ways to evaluate children's understanding of major concepts and processes presented in this unit. Some of the activities will also provide information about understanding of concepts and processes that are of secondary importance in this unit or that were introduced in earlier units.

Keeping records. One side of the Class Profile sheet (Evaluation Materials envelope, drawer 1) provides space to record results of each child's work in each activity. In evaluating children's progress we have found it most useful to distinguish three levels of understanding. These levels, and symbols convenient for recording them, are:

○ **Needs special assistance**
✓ **Check again**
● **Satisfactory**

The symbols have the advantage of being changed easily after a child gives evidence of progress. In addition to the symbol, you may add brief comments in the "Notes" column.

EVALUATION ACTIVITY

1 Identifying Requirements for Plant Growth

SYNOPSIS

Children individually identify and describe requirements for seed germination and plant growth.

Administer: ***to individual children after Part One***

Suggested time: ***3–5 minutes for each child***

EVALUATION MATERIALS

For the group:

3 cupfuls soil

Drawer 2

1 tray
1 planter base
1 water sprinkler filled with water

Drawer 3

8 –10 ryegrass seeds
1 planter cup

Drawer 4

1 magnifier
1 dip net
3 plastic bags
3 twistems

Drawer 5

1 plastic funnel

‡ Sand and Soil box

ADVANCE PREPARATION

Place one planter cupful of soil in each plastic bag. Add ¼ cup of water to Bag 1, ¾ cup to Bag 2, and no water to Bag 3. Fasten each bag with a twistem and squeeze the first two bags until the water is thoroughly mixed with the soil. Put Bags 1 and 2 aside and assemble these items on the tray: seeds, planter cup and base, filled water sprinkler, magnifier, dip net, and funnel.

EVALUATION SUGGESTIONS

Invite one child at a time to a quiet corner of the classroom and give him or her time to examine the items on the tray. Say that you are interested in what the child has learned about planting seeds and growing plants.

- First ask, "Which of these materials would you need if you were going to plant these grass seeds?"
- After the child answers, ask, "How would you use the materials?" or, "Tell me how you would plant the seeds and grow plants."
- Take out Bags 1 and 2 and put them near Bag 3.
- Then say the following and ask the convergent questions:

  "Here are three bags of soil—damp, dry, and wet."
  "Which one shows best how wet the soil should be for growing plants?"
  "How deep would you plant the seeds?"
  "After planting, will you have to wait to see plants above the soil?"

Criteria. The criteria below will help you evaluate the children's responses. Did the child:

- select all of the necessary materials for planting (seeds, soil, planter, water)?
- describe the process of planting?
- select the damp soil sample?
- recognize that the seed should be covered with soil, but near the surface?
- suggest a reasonable period of time for the grass to emerge, considering experience in the classroom?

Children who meet at least four of the criteria show evidence of a satisfactory understanding of the requirements for plant growth. Those who meet only two or three criteria should be checked later for improvement. For children who meet none or only one of the criteria, use the follow-up section.

Follow-up. Children who lack an understanding of the requirements necessary for seed germination and plant growth need additional experience. With your assistance have them plant new seeds, water, and care for the plants that germinate. Observe the children during this activity and ask them to tell you what they must do to keep their plants alive.

Additional experiences with growing plants are suggested in the Part One "Optional Activities" and in Extending Your Experience cards 2, 3, and 5.

EVALUATION ACTIVITY

2 Describing Events in Aquariums

SYNOPSIS

This activity assesses ability to describe events that occur in aquariums: feeding, birth, growth, and death.

Administer: *to groups of 4–8 children after Part Two*

Suggested time: *10–15 minutes for each group*

EVALUATION MATERIALS

1 established classroom aquarium
1 newly prepared aquarium

ADVANCE PREPARATION

To prepare a new aquarium for this activity, follow the instructions in Chapter 3 (page 15). Place the two aquariums on a table in a quiet corner.

EVALUATION SUGGESTIONS

Ask the group to come to the table and examine the established and new aquariums.

- Say that you are interested in the children's observations of the aquariums.
- Use the new aquarium as an example of how the classroom aquariums looked when they were first prepared.
- Then ask, "What has happened in the aquariums?" or, "How have the aquariums changed?"
- For children who do not respond ask, "What have you found out about the organisms in the aquariums?"
- If you still get little response, ask the child several convergent questions, similar to those below. Vary the questions as necessary until you feel certain about the extent of the child's understanding.

"What has happened to the snails (or guppies or plants) in the aquariums?"
"How does the snail (or guppy) move (or eat)?"
"How are male and female guppies different?"
"How are young snails (or guppies) different from adults?"
"What happened to the snail (or guppy) after it died?"
"Where did the baby guppies (or snails) come from?"

Criteria. Use the criteria below to help you evaluate each child's responses. Did he or she make any of the following observations?

- There are more organisms now than before.
- Babies come from adults.
- Guppies eat fish food (or plants, young guppies, or young snails).
- Snails eat plants.
- Young snails (or guppies) get larger.
- Plants increase in size.
- Plants (or snails or guppies) die.
- Organisms change when they die (they float, become fuzzy, smell bad, or eventually break apart).

Follow-up. Give individual attention to children who failed to report activities or changes in their aquariums. Point out one or two activities or changes and ask the children if they can find others. Ask them to observe their aquariums for several days and to report any new events.

EVALUATION
ACTIVITY

3 Identifying Organisms and Habitats

SYNOPSIS

This activity assesses the children's ability to identify pictures of organisms and habitats and to associate specific organisms with specific habitats.

Administer: *to entire class after Part Three*

Suggested time: *20–30 minutes*

EVALUATION MATERIALS

For each child:

- 3 Organisms and Habitats answer pages (from spirit master in drawer 1)
- 1 red crayon*
- 1 green crayon*

* provided by the teacher

ADVANCE PREPARATION

Using the spirit master make three copies for each child. You may wish to distribute the three copies one at a time during a single 20-minute period, or you may have the children complete one answer page in each of three separate 10-minute periods.

EVALUATION SUGGESTIONS

Distribute the answer pages and ask the class to find the objects on the page as you name them: seeds, snail, sagittaria, water sprinkler, funnel, tree, dip net, vacant lot, fish, aquarium, lake or ocean, and planter cup. Then explain that they will use a red or a green crayon to mark certain things on each page. Proceed in the following way:

Page 1. Tell the children,

- Write the number 1 and your name at the top of the page.
- Put a red *X* on each picture that shows where fish could live.
- Put a green *X* on each picture that shows where seeds could grow.

Page 2. Say,

- Write the number 2 and your name at the top of this page.
- Put a red *X* on each picture of an organism.
- Put a green *X* on each picture of a habitat.

Page 3. For the last page say,

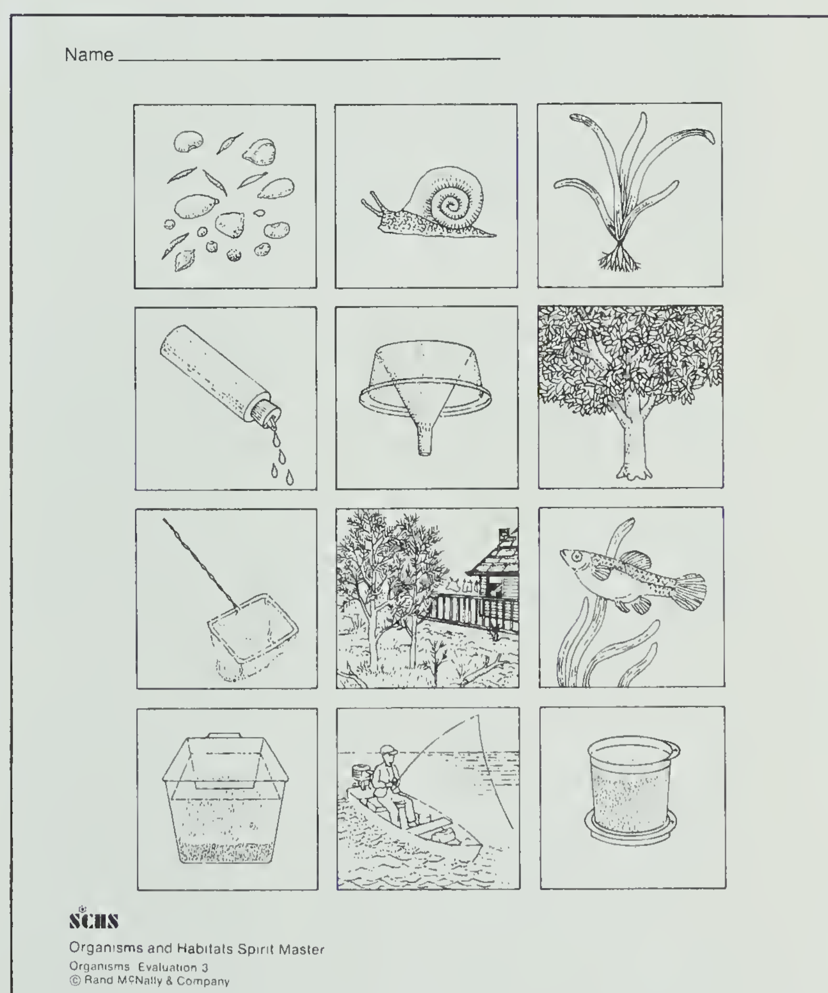
- On this page write the number 3 and your name.
- Put a red *X* on each picture of a plant or animal that can live in the aquarium.
- Put a green *X* on each picture of a plant or animal that could live in the vacant lot.

Criteria. Collect the answer pages and review them, using the following criteria:

Page 1

- Children who mark a red *X* on the picture of the aquarium and a green *X* on the planter cup recognize suitable habitats for organisms they have observed in class.
- Children who also mark a red *X* on the lake and a green *X* on the vacant lot give evidence of transferring their knowledge to new situations.

Figure E-1. Using this spirit master, make three answer pages for each child.



Page 2

- Children who mark a red *X* on pictures of the seeds, snail, tree, sagittaria, and fish recognize plants and animals as organisms. (A few children may still fail to realize that plants are organisms.)
- Some children may apply the concept to include the trees in the vacant lot, the man in the boat, and the picture of the single tree.
- Children who mark pictures of the aquarium and planter cup with a green *X* recognize habitats they have observed in class.
- Those who also mark the vacant lot and the lake green give evidence of transferring their knowledge to new situations.
- Some children may mark the trees in the vacant lot green, recognizing that they might be habitats for squirrels and birds.

Page 3

- Children who mark a red *X* on pictures of the fish, snail, and sagittaria recognize organisms that live in aquariums.
- Children who mark a green *X* on the seeds and the tree give evidence of recognizing organisms that live in vacant lots.
- A few children may mark the snail green, recognizing that some snails live on land.

Children who meet those criteria that reflect their classroom experiences have a satisfactory understanding of the concepts. (Those children who also gave evidence of transfer show an advanced understanding of the concepts.) Children who meet one or two of the criteria may be slightly confused. They may be checked again later through informal discussions.

Follow-up. Children who are confused about the concepts organism and habitat probably do not understand that organisms are alive and require certain environmental conditions to continue living. Ask the children what would happen to plants growing in the planter cups if they pulled the plants out of the soil and left them on the desk. What would happen to the plants growing outdoors if it never rained and nobody watered them? You may think of other questions.

EVALUATION ACTIVITY

4 Diagraming Food Chains

SYNOPSIS

This activity assesses the children's understanding of food chains.

Administer: ***to entire class after Part Five***

Suggested time: ***20–30 minutes***

EVALUATION MATERIALS

For each child:

1 copy of Food Chains answer page (from spirit master in drawer 1)
1 pencil or crayon*

* provided by the teacher

ADVANCE PREPARATION

Duplicate the necessary number of answer pages from the spirit master.

EVALUATION SUGGESTIONS

Give an answer page and a crayon or pencil to each child. Explain that they will be making food chains.

To make sure the children can recognize organisms in the pictures, ask them to find pictures of corn, grass, children, chickens, "bugs" (insects), and cows (cattle). Then ask the children to tell what eats what. Several relationships are listed below; you can either write these on the chalkboard or make certain the students learn them before diagraming the food chain.

- Grass is eaten by bugs, cows, and chickens.
- Corn is eaten by cows, bugs, children, and chickens.
- Bugs are eaten by chickens.
- Chickens and cows are eaten by children.

Following the discussion ask the children to make food chains, using the organisms pictured.

Criteria. Examine the children's food chains and compare them with the criteria below. Did the child:

- use arrows to connect organisms?
- draw each arrow from the organism eaten to the organism eating it?

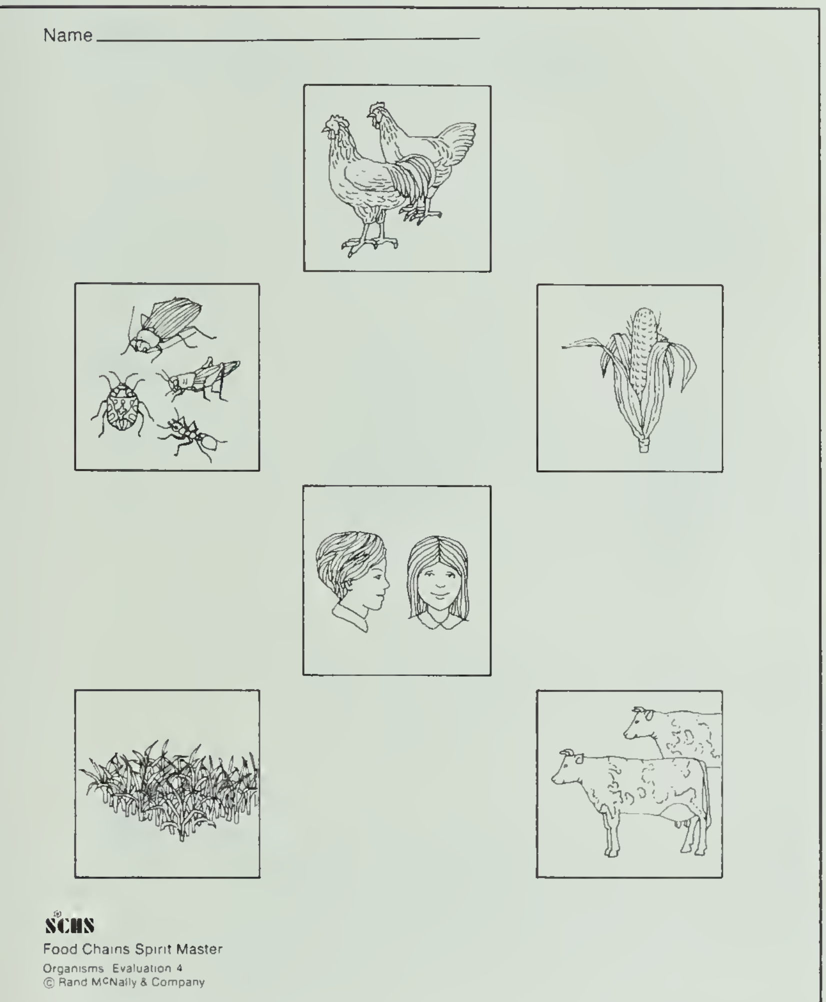


Figure E-2. The Food Chains spirit master.

- identify most of the feeding relationships accurately?

Children who meet all three criteria show a satisfactory understanding of the food chain concept.

A few children may consistently reverse the direction of the arrows (e.g., pointing from the chicken to the corn) but still recognize feeding relationships and therefore understand the meaning of food chains. Some children may connect organisms with lines or symbols other than arrows. Talk with the children individually to determine what they meant and to uncover any misunderstandings.

Follow-up. Using any classroom murals or other pictures showing an assortment of organisms, ask the children who do not understand the food chain concept to tell you what each of the animals eats. Then ask them what the arrows connect. Select a picture of a plant, and one of an animal that does not eat plants, and ask if it would be correct to link these pictures with an arrow.

EVALUATION ACTIVITY

5 Discussing Experiments

SYNOPSIS

This activity assesses the children's ability to (1) suggest hypotheses, (2) design experiments for testing hypotheses, and (3) interpret experimental results.

Administer: *to groups of 4-6 children after Part Six*

Suggested time: *15 minutes*

EVALUATION MATERIALS

For the group:

Drawer 1

Experiment picture card

EVALUATION SUGGESTIONS

Gather a group of students at a table and show them picture *A*. (Do not let them see picture *B*, on the back of the card.) Allow the children time to look at the picture. If they do not mention the soil, beetle, rock, plant, or water droplets on the top and sides of the container, call their attention to them. Also make sure they see that the container is covered.

Suggesting hypotheses. Ask the group where the water droplets on the top and sides of the container could have come from. By turning your attention to different children, you will give each an opportunity to answer. Most children will suggest the plant, the beetle, and the soil.

Designing experiments. To assess how well the children work together to design an experiment, ask them how they could find out where the water came from (or from which of the objects or organisms the water came). Allow the children to talk freely and to modify each other's designs. Children of this age rarely design controlled experiments; they usually suggest repeating the original events. However, some children will think of separating all the possible sources of moisture, as they isolated objects to determine what caused the green water and where the detritus came from in Chapters 9 and 13.

Interpreting experimental results. Turn the card over and tell them that picture *B* shows the results of

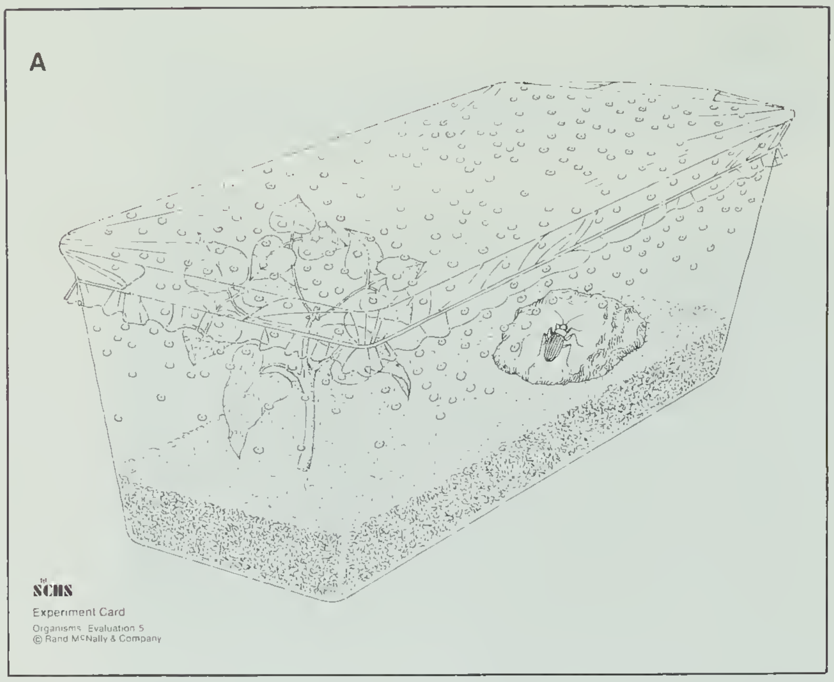


Figure E-3. Experiment picture card, side A.

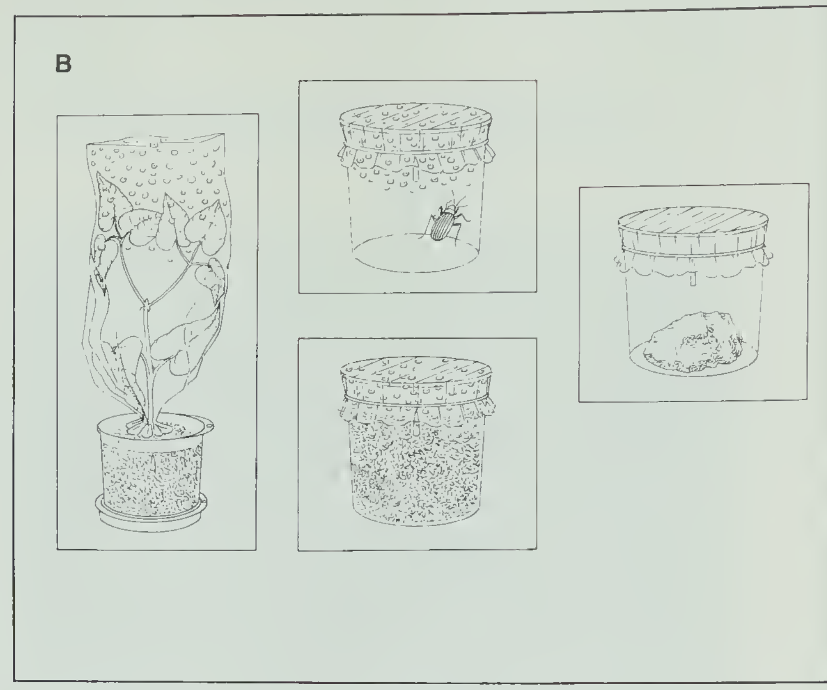


Figure E-4. Experiment picture card, side B.

an experiment to find where the water came from. Tell them each object was covered and left overnight. Give the children time to observe the pictures and to notice which of the setups contain water droplets. Then ask, "Now do you know where the water came from?" Most children will recognize that water was produced by the organisms and by the soil, but not by the rock.

Criteria. Children who can suggest hypotheses and interpret the results shown in picture *B* have given a satisfactory performance. Children who can also suggest a reasonable experiment show superior ability. Children who are unable to contribute at all or whose contributions are irrelevant show they have not had sufficient experience with the processes involved in experimenting.

The abilities tested for in this evaluation are among the major objectives of the entire SCIIS program. Do not expect many, if any, students at this level to give a satisfactory performance.

Follow-up. To develop the ability to propose hypotheses and to test them by experimenting will require far more experience than children can get in this unit. However, the Chapter 15 experiment with growing plants in pure sand, and in sand mixed with detritus, can be used to extend their experience. After the results of that experiment are available, ask the children why growing plants in pure sand was necessary to show that detritus helped plants to grow.

Attitudes in Science

These comments are designed to help you assess four major attitude areas that can indicate developing scientific literacy in children.

When using this phase of evaluation, keep in mind the question "In what ways is the child behaving like a scientifically literate individual?" During your day-to-day science teaching, look for evidence of positive attitudes in the following areas:

Curiosity. Children who pay particular attention to an object or event and spontaneously wish to learn more about it are being curious. They may give evidence of curiosity by—

- using several senses to observe organisms and other objects
- asking questions about objects and events
- eagerly examining organisms, equipment, or other materials at the time they are first distributed
- showing interest in the outcomes of experiments

Inventiveness. Children who generate new ideas are being inventive. These children exhibit original thinking in the interpretation phase of an activity. They may give evidence of inventiveness through actions or verbal statements by—

- using equipment in unusual and constructive ways
- suggesting new experiments or
- describing novel conclusions from their observations

Critical thinking. Children who base suggestions and conclusions on evidence are thinking critically. They may exhibit critical thinking largely through verbal statements by—

- using evidence to justify their conclusions
- pointing out contradictions in statements by others or
- changing their ideas in response to evidence

Persistence. Children who maintain an active interest in a problem or event for an extended period of time are being persistent. They are not easily distracted from the subject at hand. They may give evidence of persistence by—

- continuing to investigate materials after the novelty has worn off
- completing an activity even though their classmates have finished earlier or
- redoing an experiment while making some manipulative or procedural changes in order to improve the results

Of course, the behaviors related to these areas are not restricted to science; they may be observed in other curriculum areas when suitable opportunities exist.

Observing a whole class busily engaged in diverse activities makes attitude-evaluation of individuals virtually impossible for one teacher. We recommend that you focus your attention on attitudes demonstrated by four or five children during each session. You may do this by following an alphabetical class list or by concentrating on one or two teams per session. If you learn something about four or five children during any one session, then you will be able to make a note about each child four or five times in the teaching of one SCIIS unit. Active, vocal children will gain your attention more frequently; quiet children may escape your notice for some time. Adopting a plan for observing class members ensures that you will not overlook any individuals.

In addition to observing the children, an effective way to measure attitudes is to ask divergent questions about the work they are doing (see page xix). By listening carefully to their responses, you will obtain significant feedback regarding their attitudes.

Keeping records. Space is provided on one side of the Class Profile sheet (Evaluation Materials envelope, drawer 1) for recording observations about each student's attitudes four times during the unit. In the "Notes" column, you may include a short statement indicating what you observed each time the child was selected. Many teachers make their notes while the children are cleaning up at the end of the activity.

The use of this informal but organized assessment system will provide you with a great deal of information about the children's development and will assist you in planning for effective instruction in science.

Perception of the Classroom Environment

This activity indicates how the children assess the nature of the classroom during science—or how they would like it to be. The activity answers the following questions:

- Do the children see science class time being used in the way you intend it to be used?
- Do they feel that they are active participants in science class?
- Which kinds of science activity—experimenting, writing or drawing, listening to the teacher, discussing, or reading—do they generally prefer?

Young children are sensitive to suggestions from adults. To avoid unduly influencing pupils' perceptions of the classroom, you must be completely noncommittal about what you think is most important or most interesting.

In our experience, most children prefer experimenting, but some do prefer to read or listen to the teacher. Certainly all five kinds of activity are important in a balanced science program, and they should be combined in a way that benefits children most. In field tests of these materials, teachers reported that they could anticipate many children's responses, but that there were usually a few whose perceptions or preferences surprised them and helped them to adjust their teaching accordingly.

The following activity has been written in a style similar to that of the regular SCIIS activities in the hope that the children will see it as a natural part of the learning sequence rather than as a formal examination. The activity may be used at the end of each Part in the unit.

Our Science Class

SYNOPSIS

Children use a chart to indicate (1) how they think science class time was used or (2) which kind of science activity they prefer.

Administer: ***to entire class at conclusion of each Part***

EVALUATION MATERIALS

For each child:

small piece of paper*

For the class:

Drawer 1

Our Science Class chart

* provided by the teacher

EVALUATION SUGGESTIONS

Post the chart in a prominent place and tell your pupils that the pictures show what might go on during a science session. To make sure they can interpret the pictures correctly, invite them to find the pictures that show children (1) experimenting, (2) writing or drawing, (3) listening to the teacher, (4) discussing, and (5) reading.

Distribute the papers and tell the children to write their names on the papers. Then ask them to write the number of the picture that shows what happened *most* during the science session on that day (or during the last week). Some children may wish to write more than one number. Tell them they may choose two pictures; listing more than two is less effective.

Collect the papers. Did the class express a consensus? Compare the results with your own impressions. If you find that most pupils identified the picture of children listening to the teacher (3), they may feel they were not active participants in the discussion.

If many or most of the children perceive a different emphasis than you intended, review "Helping Children Learn with SCIIS" (page xvi) and the "Teaching Suggestions" in the next few chapters, to help you plan future science periods.

You may also use "Our Science Class" to assess the children's preference among the different kinds of activities. To do this, ask them to identify the picture that shows the kind of activity they like best.

Glossary

The definitions in this glossary are intended for your use and quick reference. We do not recommend that you use them verbatim to answer children's questions.

aged tap water – tap water that has been standing in an open container at least two days, allowing chlorine to escape.

anus – the opening, at one end of the intestine, through which an animal expels feces.

aquarium – a container of water in which water-dwelling plants and animals live.

aquatic – living in water.

bacteria – a group of microscopic organisms. Some are decomposers that break down feces and dead organisms, resulting in their decay. Bacterial action can often be recognized by a foul odor.

birth – the coming into being of a new individual organism.

characteristics – distinguishing features or qualities.

closed aquarium – an aquarium that is sealed to prevent anything, including air, from escaping or entering.

controlled experiment – an experiment consisting of at least two setups that are alike in all ways but one—the variable whose effect is being investigated.

death – the end of life.

decay – the breakdown of organic material due to the digestive action of microorganisms such as molds, bacteria, and yeasts.

decomposition – decay.

detritus – feces and dead plant and animal material undergoing decay.

egg – the female reproductive cell.

evidence – an observable effect that is used to justify a conclusion. For instance, a child may cite the appearance of green water in aquariums kept in the light as evidence that light turns water green.

experiment – to test or try in order to find something out.

feces – the waste matter that passes out of the anus of an animal.

feedback – information that comes to a person as a result of something done by that person. A child's answer to your question provides you with feedback about earlier instruction.

fertilizer – an artificial or natural source of minerals used by plants.

food chain – a concept that can be diagramed to depict the food relations among plants, plant-eaters, and animal-eaters. For example:

wheat → crickets → frogs → raccoons.

A food chain may consist of only a plant population and an animal population that eats it. For example: corn → humans.

grow – to increase in size.

habitat – the place in the environment where a particular organism normally lives.

hypothesis – an idea as to the cause of some event.

leaf – one of the expanded, usually green, organs borne by the stem of a plant.

minerals – naturally occurring inorganic substances. Minerals in the bodies of dead organisms are released to the soil by decomposers and are used by plants.

molds – a kind of decomposer characterized by a fuzzy appearance. Molds may be any of several different colors.

organic – the term used to describe something that is or was a part of a living plant or animal; the remains of a dead organism can be called organic matter.

organism – an individual living thing; any plant or animal.

plant minerals – minerals that plants obtain from the soil and that become a part of the plant. Commercial fertilizer contains minerals necessary for plant growth.

root – the part of a plant that grows downward in the soil and through which the plant obtains water and minerals.

seed – an immature plant that can grow into a mature plant if environmental conditions are suitable.

seedling – a young plant that emerges from a seed.

stem – the part of a plant that grows upright and supports the leaves, flowers, or fruit.

yeast – a kind of fungus that usually breaks down fruits, resulting in their decay.

SCIIS Plants and Animals

The organisms used in the SCIIS life science units have been chosen for their resiliency and ease of maintenance as well as their behavior, feeding relationships, and life cycles; no complicated feeding or housing arrangements are required. Nevertheless, some preparations for the arrival of organisms are necessary. Aquatic organisms, for instance, need aged tap water, in which the chlorine content is reduced below the level that is harmful to the organisms. Terrestrial organisms need a container with plants or animals that serve as food. On the following pages you are given both background and maintenance information on the plants and animals studied in this unit, as well as general information on planning and ordering procedures.

PLANNING THE UNIT SCHEDULE

Living organisms are the focus of the children's investigations in the SCIIS life science units. Ordering and maintaining the organisms during the teaching program are therefore important responsibilities for you and your pupils.

In planning to teach a life science unit, first examine the "Schedule of Activities" on the last page of this guide. The schedule identifies the activities in the unit and indicates the approximate time required for each one. Also indicated are the times when organisms should be ordered. Use the schedule along with the following instructions to make sure that you receive living organisms when you need them.

ORDERING LIVE ORGANISMS

The seeds and live organisms for SCIIS are to be obtained through Rand McNally & Co. In each kit you will find an envelope containing one or more forms to be used in ordering the organism shipments.

What to order. The contents of the *Organisms* shipments are as follows:

- 0-1 Guppies, pond snails, dwarf sagittaria, duckweed, algae, hornwort, guppy food, plant minerals.
- 0-2 Daphnias.

When to order. As you proceed through the Teacher's Guide, watch the "Getting Ready" notices—you will be reminded to send in each order form well in advance of the time when you will need the shipment. It is very important to you and the children that the organisms arrive on time: *You must make sure that the order is mailed three weeks before the shipment is needed.* This is because we must not only process the order, package the shipment, and allow time for shipping, but in some cases must also assist the animals. For example, the frog eggs in *Life Cycles* must be squeezed out of females, fertilized by sperm, and checked for viability just before shipment. Other organisms must be carefully selected so that they will be the correct age and size and in proper condition for use in the classroom.

How to order. Complete the order form for the shipment, including the date when needed, your name, and the school's exact address. Do *not* have these shipments sent to your district's central supply department or warehouse! The arriving organisms will need your care immediately and must not sit on a shelf. To prevent your shipment from being treated casually when it arrives at your school, forewarn the mail or package sorter of its impending arrival and firmly request that you be notified as soon as it is received. Too many organisms have died in their shipping containers after languishing for a week under a counter, only a few doors away from the waiting children.

Preparing for arrival. The preparations necessary for SCIIS organisms are minimal, but they are important. The sooner you can get the organisms out of their shipping containers and into their proper habitats, the better for the organisms.

Before any organisms arrive, tell the children that in handling the plants and animals, they should be as careful as they would be with their own pets. No SCIIS organisms will harm them, but the children should keep their hands away from their faces while working with the organisms and wash their hands afterward.

Water. Water to be used in aquariums can usually be taken from the tap, but you should not put organisms into tap water immediately. "Age" it by leaving it uncovered for at least two days to allow the chlorine to escape. If you age water in 1-gallon jugs with small necks, be careful not to fill the jugs completely, or the water's top surface area will be too small for rapid exchange of gases. To begin *Organisms* you will need to age 15 liters (3½ gallons) of water in the aquariums.

Another source of water is spring water from a grocery store or a bottled water company. Do not confuse spring water with distilled water—they are different! We do not advise using distilled water, because it is not supposed to contain any chemicals other than pure water. All animals need certain elements that are always present in spring, pond, or tap water.

Sand and soil. These items are provided with the equipment kit and have been carefully chosen for suitability with the organisms and equipment in the program. Sand to be used in an aquarium must be rinsed of dust so the aquarium water will remain clear: half-fill an aquarium with sand; add water while stirring the sand; and pour off the cloudy water. Continue flushing the sand and discarding cloudy water

until the water remains clear after the sand has settled. Distribute the washed sand to other aquariums.

The soil has been pre-mixed in the proper proportions for good growth and drainage, and it needs no further preparation.

Plants. In some units, arriving terrarium animals (such as the crickets in *Populations*) should have growing plants waiting for them. No terrariums are used in *Organisms*, but you may need to construct one for some related activity. Be sure to plant seeds at least a week before adding animals in such cases.

PLANTING SEEDS

The seeds are shipped with the kit and are available for your use as soon as you wish to begin the unit. You are probably familiar with the kinds of seeds used in SCIIS.

No seeds in the program contain toxic materials nor are they coated with such materials. Because children may put seeds in their mouths, you should avoid using seeds sold for garden use, which may have been treated with toxic chemicals to retard mold growth. The SCIIS seeds have been selected for high viability: nearly all of them will germinate, provided that they are planted and watered properly.

The only common classroom problem children have with seeds is that the seeds do not germinate. This is often caused by excessive watering. Not watering will, of course, also result in no germination, but that problem is unlikely in a classroom.

CARE OF PLANTS IN THE CLASSROOM

A classroom isn't always the best environment for plants. Your room may be very dry, cold, hot, bright, or any combination of factors. But, by concentrating on the three environmental factors over which you can have some control—water, light, and temperature—you will have success with the SCIIS plants.

Before beginning the unit decide where you will grow the plants, keeping in mind the amount of light, temperature, and drafts. Also consider whether the plants will be bumped into often, and if the children will be able to observe them easily. Using the following list will help you to find the best place for your plants and to give them good care.

Water.

- The amount of water is the *most* important environmental factor for plant development and growth. While classroom temperature and light variations can speed up or slow development and growth, excessive water variations quickly *kill* plants. A fast- or slow-developing plant is infinitely better than a dead one!
- Use enough water to darken the soil.
- The soil is too wet if (1) you can squeeze water from a large pinch of soil, (2) you can see water in the planter base, or (3) a seed rots.
- The soil may be too dry if (1) a pinch of soil crumbles, (2) the seeds in it don't sprout, or (3) the seeds in it sprout later than seeds planted in moister soil.
- We can give no prescription for how much water should be given, or how often. Each classroom is different, and you must watch your plants' soil.
- The heat and low humidity in some classrooms cause plants and soil to dry out very rapidly. In such rooms avoid placing the plants in any drafts.
- For vacation periods place all the plants together, water liberally, cover with a large plastic sheet (a drop cloth or dry cleaners' bag), and leave the light source on (outside the plastic sheet) to help maintain the temperature above 10°C (50°F). Tell the custodian to leave the light on.

Light.

- Light is not needed until plant parts emerge from the soil.
- After emergence, the equivalent of a 100-watt bulb about 80 cm from the plant is sufficient for good growth.
- To estimate the proper height of the light source above the plants, hold your hand next to the plants. If the light shining on the back of your hand feels uncomfortably warm, raise the bulb. If your hand feels cool, lower the bulb.
- The light source supplied in the kit is adjustable. Use this feature for altering both the light intensity and the temperature.
- Whether the light is from sunlight or from the light source in the kit, the plants in this unit will grow. Natural light is better than artificial unless you have so much sunlight that the soil and plants dry out or become too warm. A table or shelf near the windows, but not in the draft of the heater or air conditioning fan, is a fine place for storing plants.
- Window sills are often problem spots. Depending on the time of year, they may be too hot, too cold, or too windy; or the shades and curtains may knock over the plants.

Temperature.

- 15 to 35 degrees Celsius (59–95°F) is the acceptable range. However, 20–25°C (68–77°F) is best.
- If you use the light source provided in the kit remember that whenever the plant is receiving light it is also absorbing heat from the bulb, and the plant may be much hotter than the room. Adjust the lamp height as necessary.
- The heat from any source of light may cause the soil to dry out, which is critical. Water is more important to plants than either light or heat.

Possible plant problems. In spite of your conscientious care, you may have trouble with seeds or plants. Use the checklist below.

A CHECKLIST OF PLANT PROBLEMS

Failure of seeds to develop.

___ Too much water causes rot. Dig up one seed. If it is rotten discard the seeds, let the soil dry out, and start over.

___ If too little water has been added, the seeds will be unchanged from when they were planted. Water the soil thoroughly after replacing the seeds, and be sure they are not receiving too much heat.

___ You may not have waited long enough. Some seeds are slower to develop than others, though the kinds of seeds provided in the kits should sprout within nine days. Seeds will develop slowly if they are cold or haven't received enough water.

___ The seeds may have been planted too deeply, or the soil may have been pounded down on top of them. If you think this is the problem, dig the seeds up and plant them again.

___ In any group of seeds, a few will fail to develop. Assume 9 out of 10 seeds planted will develop, and be sure the children plant enough seeds to allow for this.

Animals on the plants or soil.

___ This usually occurs in overwatered plants. Reduce the amount of water given, and be sure none is standing in the planter bases.

___ Animals are free sources of live organisms—use them. They probably will show different life cycle forms. Aphids and gnats are common and will reproduce on plants and soil.

Blemishes.

___ Symptoms such as discolorations, leaf curl, and fuzzy spots on soil or plants are probably caused by molds or other fungi. Dry the plants out by watering them less and increasing the amounts of light and heat they receive.

___ Blemished plants will not necessarily die. To prevent infection of healthy plants, isolate the infected plants until they recover.

Breakage.

___ Protect plants from breaking by storing them where the children are not likely to knock them over or brush against them.

___ Allow only a few children to retrieve their plants at a time. This reduces jostling that might otherwise occur.

___ Encourage children to be gentle with the plants as they work with them.

___ Avoid storing plants near windy doorways or windows, where they might be blown over.

___ Use support sticks and ties for tall plants grown in pots.

Miscellaneous problems.

___ Sick-looking or dead plants may have lost too much water over the weekend. The solution is to water plants more on Fridays, or to cover them with waterproof plastic wrap, being careful the plastic does not break them.

___ Diseases are possible, but unlikely. Discard any diseased plants and plant new seeds.

___ Weak stems are usually caused by an overabundance of water, by the addition of more soil after the plant has sprouted, or by insufficient light. Have the children use less water, support the plants with sticks and ties, and be especially careful with these plants.

___ Kinked stems can be salvaged if they are kept straight with splints. Use yarn, tape, or a twistem to attach a stick or pencil to the weakened section of the stem.

CARE OF ANIMALS IN THE CLASSROOM

All the animals selected for use in this program will live in your classroom. However, we often find variations among classrooms that can cause some problems. Your room may be too dry, cold, bright, or hot for some of the animals. In many schools the heat is turned down at night and on weekends; some schools are dark; in others the blinds must be pulled down every afternoon; and some are in areas of very low or high humidity. Some rooms with a southern exposure heat up. Rooms with windows on the west side may have bright sunlight at four or five o'clock, after everyone has gone home—everyone but the organisms, which then find themselves literally in hot water. The next morning the water has cooled and everything looks normal, but many organisms are dead.

To prevent such disasters and the resulting disappointments for the children, set aside ten minutes to read the section beginning on the next page, describing the key points in maintaining each of the animals. Environmental factors which can severely affect classroom animals are water, light, temperature, and food.

Water. As all the animals in this unit are aquatic, all you have to do is keep enough aged tap water in the aquariums.

Light and temperature.

- The presence of absence of light alone will not harm your animals. However, the light source also gives off heat that builds up inside animal containers.
- Check the temperature with the back of your hand, as described on page 75.
- For each animal, there is an optimum temperature, but none of the animals supplied will be harmed if you keep the temperature between 10°C (50°F) and 25°C (80°F).
- Temperatures below 23°C (75°F) will tend to slow the rate of development a little. But as with plants, an organism that develops too slowly is far better for your purposes than a dead one.
- When in doubt about whether to raise the temperature another degree or two, ask yourself whether there is danger of raising it too much if you forget to monitor the increase. If so, do not try to raise the temperature. Remember, this unit *cannot* be taught without live organisms.

Food.

- Daphnias eat algae, and snails feed on plants and detritus in the aquarium. You do not need to provide food for them under ordinary conditions.
- A small pinch of the fish food supplied in Shipment O-1, given two or three a times a week, is ample food for the guppies.

PLANT AND ANIMAL SHIPMENTS FOR *ORGANISMS*

Algae.

Receiving the organisms. When the shipment arrives, shake or swirl the container, then look at the liquid to see if it is green. If it is not, call the telephone number given with the shipment and request a replacement.

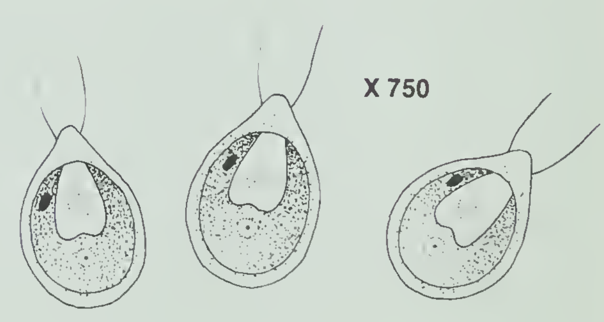
Pour the contents of the shipping container into an aquarium of aged tap water and place the aquarium near a natural or artificial light source.

Classroom care and maintenance. The SCIIS algae ('al-[ı]jē) grow best at room temperature (15–25°C, or 60–80°F), in aged tap water having a large surface area for absorption of air. Some substances, including those in the plant-minerals concentrate provided for this unit, accelerate algal growth. Even without the addition of special minerals, however, algae may grow. For that reason you should not place an algae aquarium in a strong light unless you are trying to promote overgrowth, as in this unit. You can place it within the lighted area around a SCIIS light source, but not too close to the bulb.

Description and natural history. Like all other green plants, algae have the ability to photosynthesize—to manufacture food from carbon dioxide, minerals, and water, using energy from the sun. But, unlike many other plants, algae do not have roots, stems, leaves, or flowers.

The algae you receive are microscopic; however, a large population in an aquarium will give the water a green color. Other kinds of algae may be seen as

Figure L-1. Green algae as seen through a microscope.



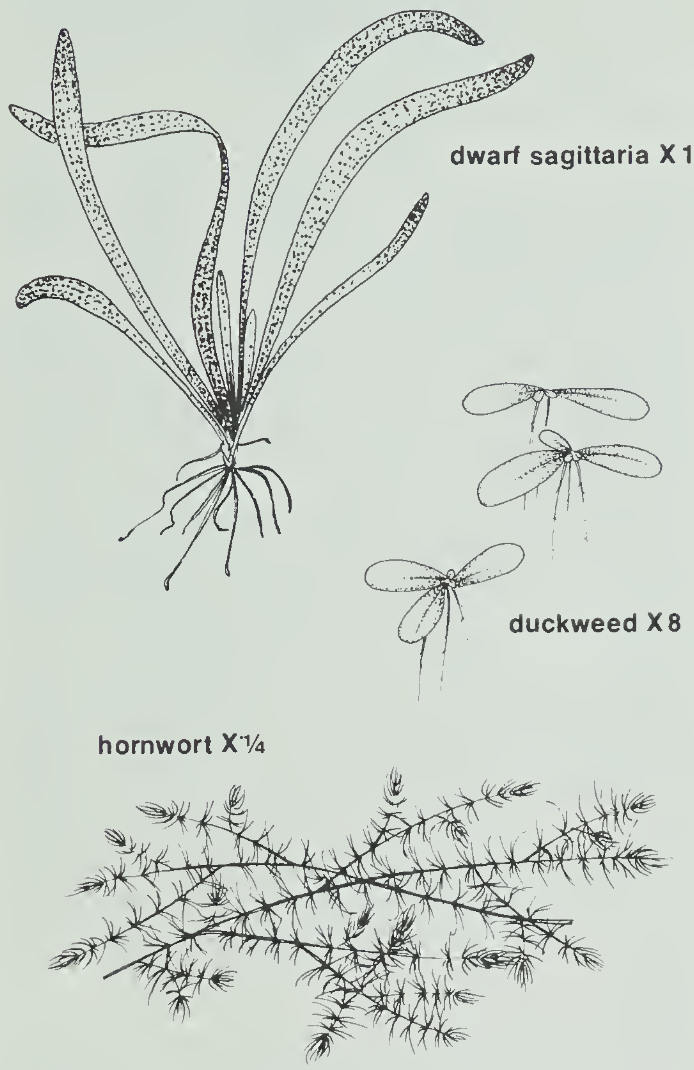
dense layers of green filaments floating on the surface of ponds and ditches or attached to rocks in a stream.

The algae used in the SCIIS program live in freshwater ponds and are food for many organisms.

Disposal. Being food for snails and other animals, algae are unlikely to cause any problems of disposal—they will be eaten. If you do wish to dispose of an algae aquarium, first pour the water into a sink drain. Then, with the tap water running, scrape the aquarium walls with a wooden stick, rinse the walls, and discard the rinse water. Wipe the aquarium out with a rag or paper towel.

Other aquatic plants. In addition to algae, the *Organisms* aquariums contain hornwort *(Ceratophyllum)*, duckweed, and dwarf sagittaria.

Figure L-2. Aquatic plants.



Receiving the organisms. When Shipment O-1 arrives, remove the cover of the duckweed shipping container and pour the contents through a strainer if one is available. Then transfer the plants to a container of aged tap water. Discard any plants that are not bright green or that have a bad odor. Place the container near a light source. The duckweed container should be opened on the day of arrival.

The plastic bags containing snails, sagittaria, and hornwort should also be opened immediately and the organisms placed in aged tap water. Plant the sagittaria in aquariums containing aged tap water and about 3 cm of sand. Dig a hole and bury the plant roots under the sand. Hornwort can simply be rinsed and dropped into the water.

Classroom care and maintenance. Like algae, these aquatic plants require moderate light and a 15–25°C (60–80°F) temperature.

Description and natural history. Duckweed is a tiny flowering plant consisting of a single frond (a leaf-like structure) with one or more trailing roots. New fronds bud from old ones when the plant reproduces. Very often two or more fronds are connected, but in such a case each frond is considered a separate plant. Duckweed often forms a green mat on the surface of a pond or a slow-moving stream. Flowers form in clusters of threes on the edges of fronds; they are rarely seen on duckweed growing indoors. Ducks, geese, fish, and snails eat duckweed.

Many varieties of sagittaria, commonly called arrowhead, grow in ponds and rivers of the eastern United States. The dwarf sagittaria supplied for SCIIS aquariums does not have the typical arrow-shaped leaf; rather, each leaf is ribbon-shaped. The plant sends off runners with young plants growing from them, and the white flowers float on the water surface.

Hornwort has bushy stem tips, which account for the plant's other common name of coon tail. Leaves are arranged in spiral fashion around the stem. When flowers and fruits form, they are seen as small red cylinders. Muskrats and birds feed on these plants.

Disposal. To dispose of excess plants, wrap them in a towel and discard.

Pond snails.

Receiving the organisms. Be sure, when receiving a shipment of snails, to place them only in a container of *aged* tap water. Though their shells may make them appear hardy, snails are sensitive to acidity and small amounts of certain compounds in tap water.

Classroom care and maintenance. For normal classroom use, no special foods are necessary for the snails; they feed on algae and decaying material in the aquariums.

Description and natural history. Snails are frequently found climbing on plants, rocks, and other submerged objects; small ones can even be seen hanging suspended from the surface film of water. Snails are eaten by fish, ducks, and large insects.

The large soft part of the snail which protrudes from the coiled shell is called the foot. It consists mainly of muscle tissue and is the organ of locomotion. Usually snails move by creeping over a thin film of mucus deposited by the foot.

The head is located at the front of the foot and has two tentacles. On each tentacle is an eye. The mouth is on the lower surface of the head. Within the mouth there is a rasplike tongue which scrapes across the food material and reduces it in size for swallowing.

Most snails eat the soft tissues of plants, but some are scavengers that eat dead plants and animals. They will remove algae and detritus from the aquarium walls, making the contents more visible.

Figure L-3. A pond snail.

Snails lay eggs in gelatinous clumps on leaves, on sticks, or on other objects. Frequently you will find snail eggs on aquarium walls. Tiny snails, looking very much like the adults, crawl out of the jellylike mass after one or two weeks.

Disposal. When you have finished with them, pond snails will make a good addition to aquariums in other classrooms. If they must be killed, put them in a plastic bag and freeze them.

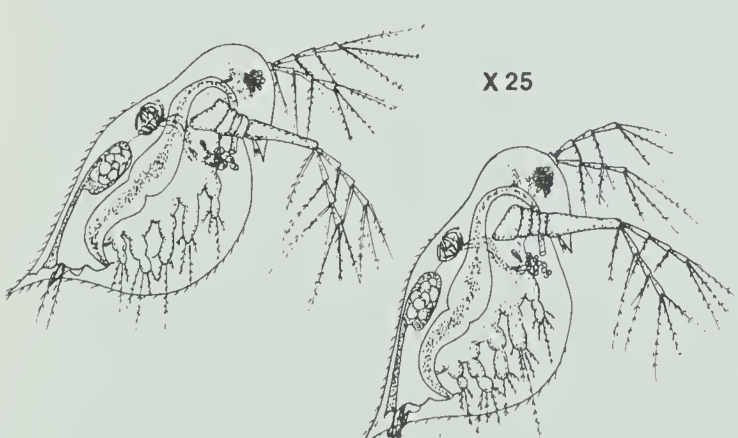
Daphnias

Receiving the organisms. When you receive the daphnias ('daf-nē-əz), pour the contents of the shipping container into a dip net, discarding the liquid. Then turn the dip net inside out, submerge it in a culture of algae you have prepared, and wash the daphnias from the net.

Classroom care and maintenance. Though daphnias do not require light, algae do. Light that produces good algal growth will benefit both populations.

Place the culture of algae and daphnias near enough to the light source that the light shines onto the water, but not too near: the culture can easily become too hot. The optimum temperature range is 20–25°C (65–80°F). (You can estimate the temperature at any given point under the light source by placing your hand there. If the light shining on the back of your hand feels uncomfortably warm, the temperature there is too high for other organisms as well. Similarly, if your hand feels cold, that place is probably too far from the light.) Adjust the height of the light bulb or move the aquarium to the side if the water gets too hot. Above or below their temperature range, the animals will die, or they will produce special black egg cases rather than live young.

Figure L-4. Daphnias.



If you wish to maintain a culture for several months, transfer some daphnias to a fresh container of algae water every two or three weeks.

Description and natural history. Daphnias *(Daphnia)*, also called water fleas, are small aquatic animals related to lobsters, crayfish, and crabs. The animals can often be found in freshwater ponds, lakes, or slow-moving streams, where they feed on algae and decaying organic material.

The shell (carapace) and some of the organs are transparent. The vibrating legs, the single black eye, and the intestine (usually filled with green algae) show through the carapace. These parts, as well as the two large antennae which are used for swimming and which are not enclosed by the carapace, can be seen with a magnifier.

When fully grown a daphnia is about 3 mm long. It grows in distinct stages rather than showing gradual and uninterrupted increase in size. Its rigid carapace is cast off periodically and, as the animal grows, a new and larger carapace forms and hardens.

Most daphnias are female and can reproduce without fertilization. Ten to twenty eggs appear in the brood pouch every few days. These eggs quickly develop into tiny daphnias inside the pouch, and the young are released live. The young grow rapidly and soon produce eggs of their own.

Disposal. After the unit is completed, any remaining daphnias can be used as an excellent fish food.

Guppies

Receiving the organisms. When the shipment arrives, lower the shipping container into an aquarium in which tap water has been standing for at least two days. After one or two hours, when the contents of the shipping container are at aquarium temperature, pour the contents through a dip net; discard the liquid. The guppies will be caught in the dip net and can be transferred to one or more containers of aged tap water. Be sure to carry out the transfer within a few hours of receiving the guppy shipment. Add several sprigs of hornwort to each container. If guppies are not distributed to the children's aquariums within three or four days, provide daphnias or commercial fish food.

Classroom care and maintenance. Guppies often eat their young. If you want to increase the size of your guppy population, remove the adults and place them in a separate aquarium.

If a guppy has gray patches on its body or otherwise appears unhealthy, remove it from the aquarium before other fish are infected. Either dispose of the fish or isolate it in a separate container of aged water. If an

Figure L-5. Guppies.

isolated fish later seems healthy, it can be reintroduced to the aquarium.

Description and natural history. Guppies are small tropical fish. Females are usually grayish in color, while the male is often very colorful. The male is smaller than the female. Also, the male has a spine-like structure on the anal fin (the fin located just in front of the tail, on the animal's underside). This structure is used for transferring sperm to the female.

Young guppies are born alive. Prior to birth of the young, the abdomen of a pregnant female guppy becomes swollen, and a black spot appears on each side just above the anal fin. Female guppies may produce from six to sixty "baby guppies" (fry) in one brood.

Immature guppies feed on live organisms such as daphnias. However, in the aquarium they can be fed dried fish food. Because the guppy's mouth is on the upper part of the head it can eat food that is floating on the water surface.

Disposal. Give them away if possible. To dispose of unwanted guppies, place them in a plastic bag and freeze, then discard them in the bag.

Design and Use of the Kit

The equipment kit has been designed to help you teach the unit effectively. Except as noted below, all materials needed for a class of thirty-two students have been included. The items are packaged for convenient removal, use, and reuse. In response to feedback from users of SCIS, we have placed a contents list on the front of each drawer. In addition, the chapter "Teaching Materials" lists are now arranged by drawer number.

Familiarize yourself with the entire kit as well as with the diagram and lists on this page. You should inventory the kit before beginning to teach the unit, using the lists on this page for checkoff and notes.

Drawer 1, containing the printed materials, is a separate box. Place it on top of the kit as indicated in the diagram.

Some common items are to be provided by the teacher. The "Teaching Materials" list for each chapter indicates what you are to provide, and the "Getting Ready" notices give you advance warning about these items when necessary.

The live organisms studied in this unit are not included in the kit. Instead, they will be sent separately when your completed order forms are received. Complete directions for ordering are on page 77.

Drawer	Item Description and Quantity
1	1 Teacher's Guide 32 student manuals 2 sets of Extending Your Experience cards and display box 1 evaluation packet
2	32 planter bases 1 light source 3 water sprinklers 16 trays 1 set of Live Organisms Shipments order forms
3	32 planter cups 1 package pumpkin seeds 1 package pea seeds 1 package mustard seeds 1 package ryegrass seeds 1 roll labels
4	1 dip net, coarse 1 dip net, fine 33 tumblers 16 magnifiers 4 six-liter containers 32 plastic bags 32 twistems
5	16 medicine droppers 1 baster 16 funnels 4 six-liter containers 16 plastic vials 10 fluted containers 16 plastic plants 1 package cotton balls

Sand and Soil Box

1 twelve-lb bag of sand
4 eight-lb bags of soil

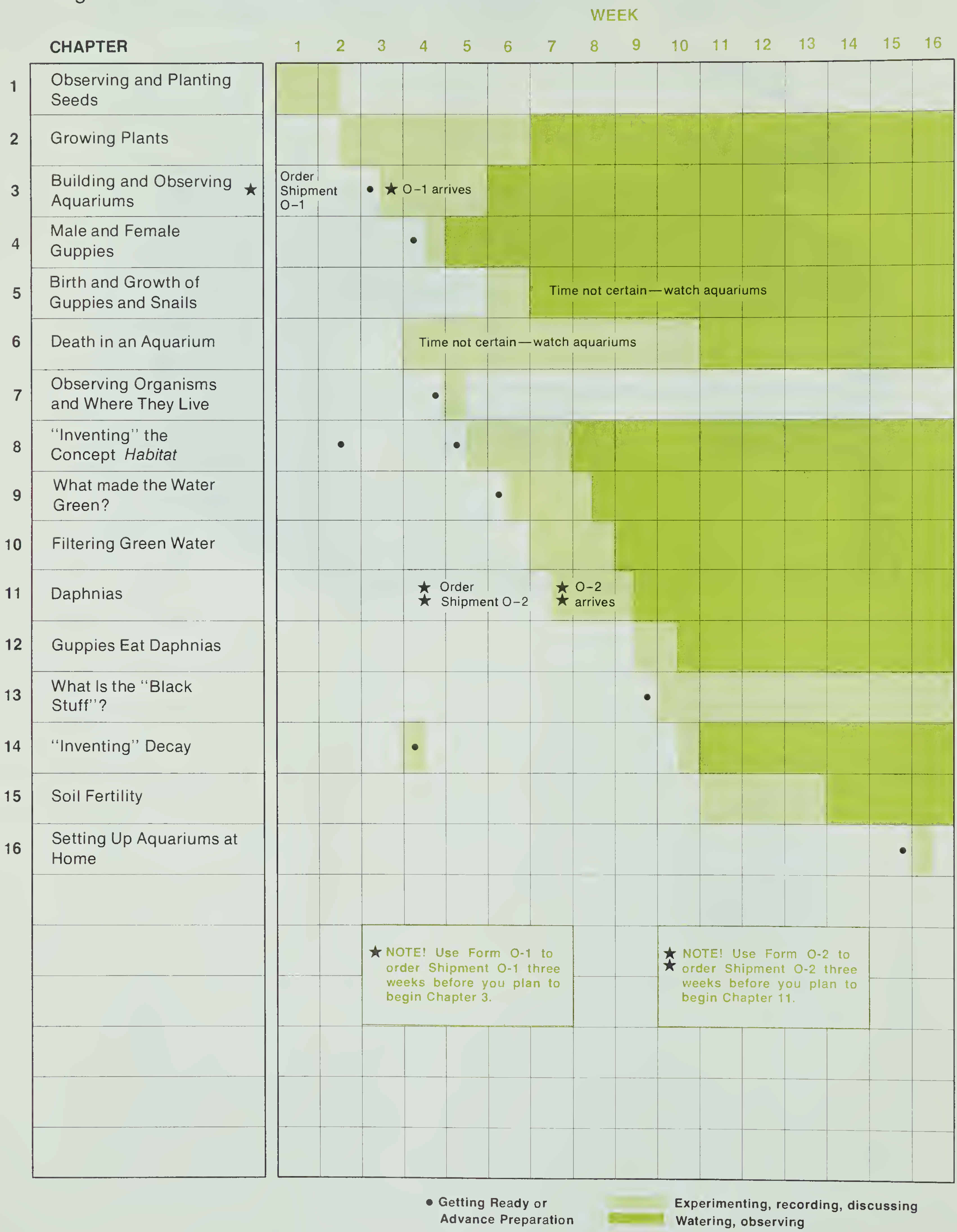
Live Organisms Shipment O-1

10 male guppies
26 female guppies
18 pond snails
16 dwarf sagittaria
1 jar duckweed
1 pint green algae
1 package hornwort
1 package fish food
1 bottle plant minerals

Live Organisms Shipment O-2

150 daphnias

Organisms Schedule of Activities



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